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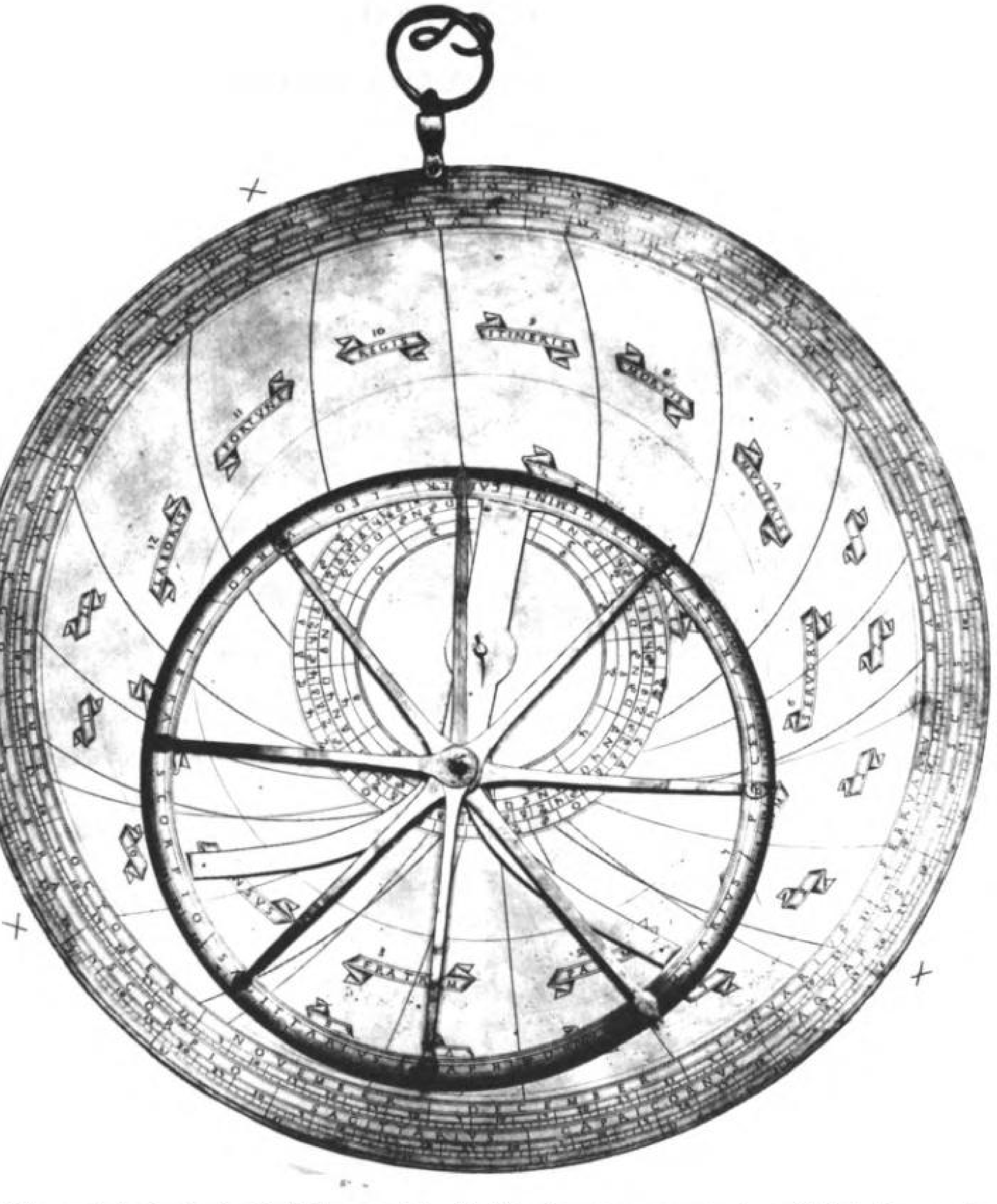
J. D. NORTH

HOROSCOPES AND HISTORY



Frontispiece – Astrological astrolabe, combined with planetary equatorium (this being on the side not shown). This unusually large (422 mm diameter) and finely executed instrument is perhaps of the sixteenth or late fifteenth century. The rete has been stripped of most of its traditional functions, leaving a skeletal ecliptic ring. This has loosely pivoted radial pointers, simply to record the planetary positions. The main plate carries lines for the seasonal hours (below the horizon only) but also, easily confused with them, a full complement of fixed boundary lines for the equatorial (Regiomontanus') method. These are for a southern Italian latitude: from measurements taken from the photograph, it seems that Salerno or Naples might have been intended. The astrological houses are here labelled, with fairly conventional Latin names: Vite, Census, Fratrum, Patrum, Filiorum, Servorum, Mulieris, Mortis, Itineris, Regis, Fortune, Laboris. The outer scale is a calendar ring, while the inner shows the terms, faces, and domiciles of the planets.

The instrument is in the Settala collection in the Pinacoteca Ambrosiana, Milan, and the illustration is reproduced by courtesy of the Biblioteca Ambrosiana.

HOROSCOPES AND HISTORY

ohn avid
J. D. NORTH

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PREFACE

A few words of explanation are called for, if this monograph is not to be censured for failing to live up to ideals that are quite alien to it. It is not meant to be a history of astrology, although it does offer a historical sketch of certain crucial mathematical techniques used in that subject during nearly two millennia – namely to divide the ecliptic into the twelve mundane houses. I hope that my sketch may replace certain standard historical accounts that are as wrong as they are threadbare, but even more, I hope that it will allow others to fill in some of the many lacunae that it exposes to view, in particular, in our knowledge of the transmission of scientific ideas. While not meant as a comprehensive history, it should serve as a warning and an aid to those who are in the habit of describing scholars as having 'practised traditional astrology', and who erect grandiose historical and sociological theses on the basis of such descriptions, without looking more deeply into the question of what was traditional and what was not. As explained in its introduction, however, and as shown at length in its second part, this book has a further purpose, for with its help horoscopes may be made to yield up useful fragments of historical information. They may provide dates, of course, from planetary positions, but also indicate geographical latitudes, not to say astrological traditions. In consequence, they are potential indicators of textual provenance, or perhaps of routes of textual transmission. The necessary mathematical basis is invariably provided, but those who are interested in the work only as a historical tool might well make use of the computer programme that is included as an appendix. Heaven forbid that the book should be judged as a manual for astrologers – even though it may be safely expected to become compulsory reading for all their introductory courses.

This book is very much a child of the Warburg Institute. It owes its conception, if not its nativity, to a meeting on the life of Adelard of Bath, organized there by Charles Burnet in the spring of 1984. Will Ryan suggested at that meeting that the introduction to my paper (on the Norman horoscopes) would bear expansion into a volume of the Warburg Institute's *Surveys and Texts*, and on the same occasion, Francis Maddison's mention to me of the existence of the astrolabe described here in section 1.22 finally persuaded me to write the book. I owe a great deal to their subsequent help, as I do to Charles Schmitt, joint editor of the series, and indeed to numerous other friends – all acknowledged, I hope, in appropriate places in the text. One person I must thank especially here is Edward Kennedy – who, as it happens, was also present at the Adelard meeting. His comments have been as pointed and as valuable as they have been numerous.

Debts of a more general sort I owe to my colleagues in the Philosophical Institute of the University of Groningen, whose generous grant of leave of absence – not to mention a civilized disregard for the way it would be used – made the writing of the book possible. Since much of the history it describes has to do with Merton College in an earlier period of its ascendency, it is a pleasure to thank the College for its hospitality during my absence from another climate. And finally, I must thank the Royal Society for supporting the publication financially. In the hope that its subject matter will not be too great an embarrassment to that august body, I have ended the book with what must be counted its finest example, from the pen of its first President.

Glendower: At my nativity
The front of heaven was full of fiery shapes
Of burning cressets; and at my birth
The frame and huge foundation of the earth
Shak'd like a coward.
Hotspur: why, so it would have done at the same
season, if you mother's cat had but kittened.
Henry IV Pt. 1, III,i.

To My Parents

INTRODUCTION

THIS is a study of what Otto Neugebauer, echoing with some irony the words of George Sarton, called a 'wretched subject'. There are many ways of reading it, and in some ways it is analogous to a manual of palaeography. Horoscopes, like scripts, carry a meaning of their own, but there are reasons for studying both, regardless of whether we sympathize with their meanings. Horoscopes, like scripts, have their own history, but both may be seen as useful historical indicators by historians having little or no interest in that history. As a study of the history of a very narrow band of astrology, this monograph deals with the mathematical problem of dividing the zodiac into the so-called 'mundane' houses (as opposed to the planetary houses, the twelve signs of the zodiac themselves). We shall find that there are many different ways of effecting the division, and that from a historical point of view, the mathematical problem was far from trivial. There are a few tenuous rays of light to be shed from this quarter on the history of mathematics generally. The history of astrology has not been much studied from this perspective, a fact that is witnessed by the extraordinary confusion of personal names in existing historical sketches of the alternative methods. I have found it necessary to revise orthodox ascriptions so often that I have no expectation that my own account of the probable origins of the methods can be anything more than provisional. Such as it is, the history of the methods will be found in Part I, where also the underlying mathematics is developed in a sufficiently distinct way for it to be applied as a historical or literary tool. Some examples of the analysis of horoscopes are included in Part II, where the historical interest is occasionally independent of the astrological, but where it often derives from the fact that the example reflects back on the evolution of astrological traditions.

Horoscopes turn up in so many historical contexts, astrological and otherwise, that historians should at least be made aware that they can be made to yield up historical information. Although this will be slight, even fragments might be enough to tip the historical scales – as is well known from the application of chronological and palaeographical techniques, for example. Historians faced with a nativity are almost always inclined to ask how it would have been interpreted. The answer is usually 'As its subject would have wished'. While not wishing to trivialize this corner of the subject, I must say at the outset that, like Hotspur, I shall shun the problem of interpretation, at least in the usual sense. One of my aims will be rather to establish a few principles that will allow us to learn something of the circumstances and technique of *the person who cast* the horoscope. Of necessity, I begin by considering how this was done. As I have already said, I shall stay throughout with the problem of dividing the zodiac into houses – 'domification', as this was sometimes called.[1]

This strictly geometrical problem has been studied much less intensively than that other essential element in casting a horoscope, namely the correct placing of the planets in longitude, a problem that will here be taken very much for granted. There are certain parallels between the two different techniques. Both were often done crudely, simply because accurate working was time consuming. Tables were usually available in both cases, but there were strong incentives to simplify matters with the help of instruments – equatoria in the case of the planets, the astrolabe for domification. The astrolabe was in any case occasionally used to establish the time of a nativity, although, as we shall see, some nativities were cast many years after the birth, the crucial moment of which was assessed by astrological means. One of our central problems will be that of establishing which tables, if any, were used, and for what geographical latitude. It will emerge that horoscopes (and of course we are not dealing only with nativities) were often lifted bodily from alien texts, or based on tables used at quite inappropriate latitudes. They may even so be capable of providing slight but valuable information about textual transmission and astronomical practice, not to say levels of expertise, and seriousness of astrological purpose. Among other things, I want to put an end to a misconception that seems to be flourishing in literary commentaries and elsewhere, that there were so many alternative methods in use that it is impossible to make any safe inference in this matter. I shall try to establish some limits of safety.

---

[1] The Lat. *domificare* gives M.Eng. *domifie*, and since the 15c.(?) canon in MS Bodley 340, f. 13rv, is earlier than anything quoted under this head in OED, its opening words are worth mentioning here: 'For a declaracion of thes tabullis be fore wryten wyche byn callyd the tabullis to domifie the 12 howses . . .'

Although the main focus of this study will be medieval and early modern Latin traditions, and the emphasis strongly English, we shall need to look back to Greek and Islamic astronomy for most of our basic principles. These have been so well explained in the works of Bouché-Leclercq, Neugebauer and van Hoesen, and others, that it would be foolish to offer more than a sketch of their history in a monograph of this sort.[2] I begin with questions of nomenclature, the mathematical notation to which I shall adhere throughout, and some essential mathematical principles.

---

[2] Bouché-Leclercq (1899); Neugebauer and van Hoesen (1959); Neugebauer (1975). The last work is not devoted primarily to astrology, but has the essential mathematical history, and like the second item includes a valuable bibliography.

PART I

THE MATHEMATICAL PRINCIPLES AND THEIR HISTORY

1.1. *The houses*

The word 'house' (*domus*) is ambiguous, and I use the word 'domicile' (which is also ambiguous) to denote the fixed planetary houses (*domus*, οἶκοι), namely the signs of the zodiac, regarded each as the home of a particular planet.[3] The houses (*domus*, *loci*, τόποι) that concern us here are the divisions of the ecliptic (or zodiac, loosely speaking) that depend on the way this is cut at the moment of birth, or whatever, by the horizon and meridian. The rising point of the ecliptic, which turns as a whole with the daily rotation, is the ascendent (*ascendens*, *horoscopus*, ὡροσκόπος). The twelve houses are usually counted from this point, working in the direction of increasing ecliptic longitude. There was in antiquity a system of eight, rather than twelve, houses. The system (ὀκτώτοπος) is known to us, for instance, from the early first-century Roman astronomer Manilius, and we shall find that there were echoes of it in the sixteenth century.[4] Very occasionally, the Lot of Fortune was taken as a starting point for a horoscope, but it will rarely be necessary to refer to the corresponding doctrine in the following pages.[5] In some traditions, a point preceding the ascendent by 5° in longitude was used in its place. This convention, although possibly rare, is testified in the middle ages, and will be taken into account.[6] The simplest mode of division is to take twelve equal houses of 30°, but for the best astronomers this method was too straightforward to be much favoured, and a whole range of alternatives was found in the course of a millenium and a half.

When the houses had been cast, each was given a special significance. In the case of a nativity, for instance, the future *life* of the subject was affected by what was in the first house, *business* by what was in the second, and so on (through *brothers*, *parents*, *children*, *illness*, *marriage*, *death*, *travel*, *honours*, *friends* and *enemies*). There were many variations in these interpretations, and, of course, others were used when the horoscope was cast for some other occasion, such as the commencement of a journey, the discovery of a lost possession, a medical prognosis, or a question of likely fortune in war. Such interpretation is, as I said at the outset, not my concern.[7] Connected with the problem of interpreting a horoscope there is however a way of classifying the houses, for which the relevant vocabulary might prove useful. The houses are designated as 'cardines' (the four houses, 1, 4, 7, and 10, that begin from the cardinal points), 'succedent' or 'following' (ἐπαναφορά, about to rise, said of houses 2, 4, 8, and 11), and 'cadent' or 'falling' (ἀπόκλιμα, said of 3, 6, 9, and 12). The meanings of these terms will be clear if houses 1, 9, and 10 are taken as specimens, and the daily rotation is considered.

The horoscope (a word used here in a loose sense, to mean the figure that is drawn to summarize the astrological situation) may take on one of several different outward forms. Some examples are shown in Fig. 1, where the houses are numbered in the usual order, and where λ denotes the ecliptic longitude of the point at which a house begins. Thus λ_1 is the longitude of H, the ascendent; λ_4 that of *imum medium caelum*, the point in which the ecliptic cuts the continuation of the meridian (see Fig. 2); λ_7 that of the descendent point, invariably $\lambda_1 \pm 180^\circ$; and λ_{10} the longitude of *medium caelum*, the culminating point of the ecliptic, that is, where it cuts the meridian. Great circles through N, the north celestial pole, and the cusps of the houses will cut the equator in points of right ascension α_1, α_2, etc., and Fig. 3 shows the full complement of ecliptic and equatorial divisions as they might appear in stereographic projection, that is, for instance, to one who was using an astrolabe to cast the houses according to one particular method of division.[8] *The vernal point is denoted by V, the eastern point of the horizon by E, and the northern and southern points by N′ and S′. A is an azimuth, namely EH. The geographical latitude of the place for which the figure is cast is* ϕ, in medieval writings usually well described as *elevatio poli* (NN′). K is the point of right ascension α_1, while δ is the declination HK. The obliquity of the ecliptic, denoted by ε, is subject to secular change, but the writers we shall be examining took one of only a handful of figures, and this usually tacitly and by accident, rather than for any systematic reason. Thus, as we shall see, a Ptolemaic value of $23;51^\circ$ was often inadvertently accepted by astronomers who, if asked to quote a figure, would probably have given the 'Toledan' $23;33,30^\circ$.[9]

---

[3] See section II.27 and 28 below. On the ancient system, see Bouché-Leclercq (1899), pp. 276–80.

[4] The Sun and Moon take one house each, while the other planets have each a day- and a night-house. Cf. Ptolemy, *Tetrabiblos*, I.17 (ed. Robbins, 1940).

[5] The Lot of Fortune in its simplest form is a point on the ecliptic with longitude equal to that of the ascendent increased by the amount that the Moon's longitude exceeds the Sun's. See Bouché-Leclercq (1899), pp. 288–91.

[6] The other 'angles' are also replaced by points preceding them by five degrees, on some naive interpretations, but this is not mathematically acceptable.

[7] On the basic meanings of the houses, see Bouché-Leclercq (1899), pp. 281–8.

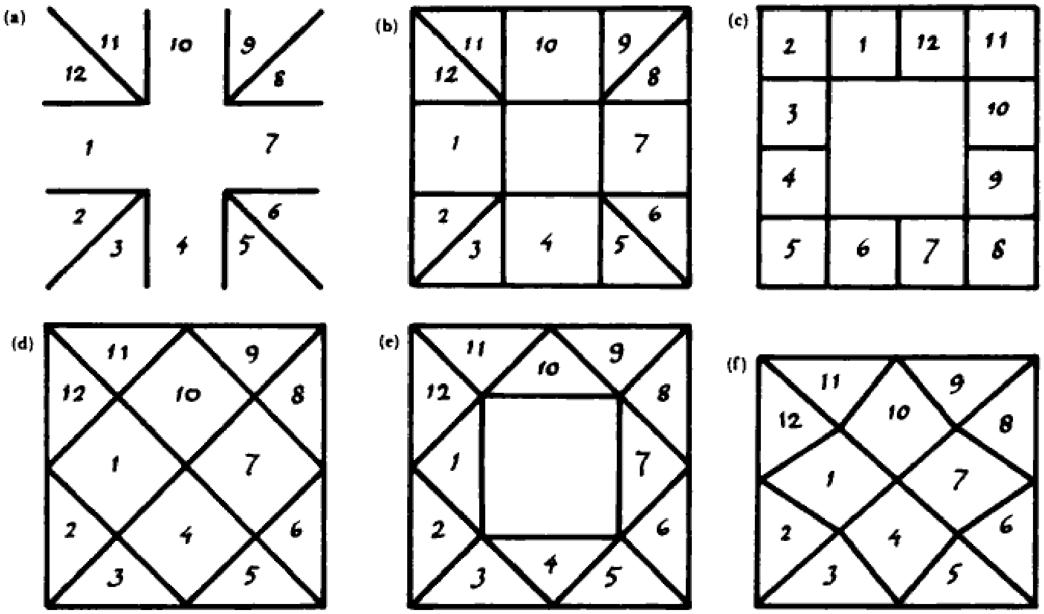

Fig. 1 Six forms of horoscope ('scheme', 'figure', 'theme', 'square', etc.). There are several others (see pp. 83, 91, and 150 below, for examples), but most horoscopes before the sixteenth century will be found to be of one of the forms (b) to (f). Actually (a) is a unique Byzantine example of the year 497 (see p. 72 and Fig. 19). Note that the first house usually comes at the left of the figure, but occasionally in types (b) and (c) it comes at the top, as shown in case (c). Type (e) is perhaps the most common form. Its popularity was reinforced by the printed book, where it was much favoured.

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[8] For the principles underlying the instrument's construction and use, see North (1974), and also sections I.21–3 below.

[9] The notation has many typographical advantages, especially in tables, and it will be used here almost invariably – in tables usually without any degree marks. (Compare the traditional notation, which would make the second figure in the text 23° 33′ 30″.)

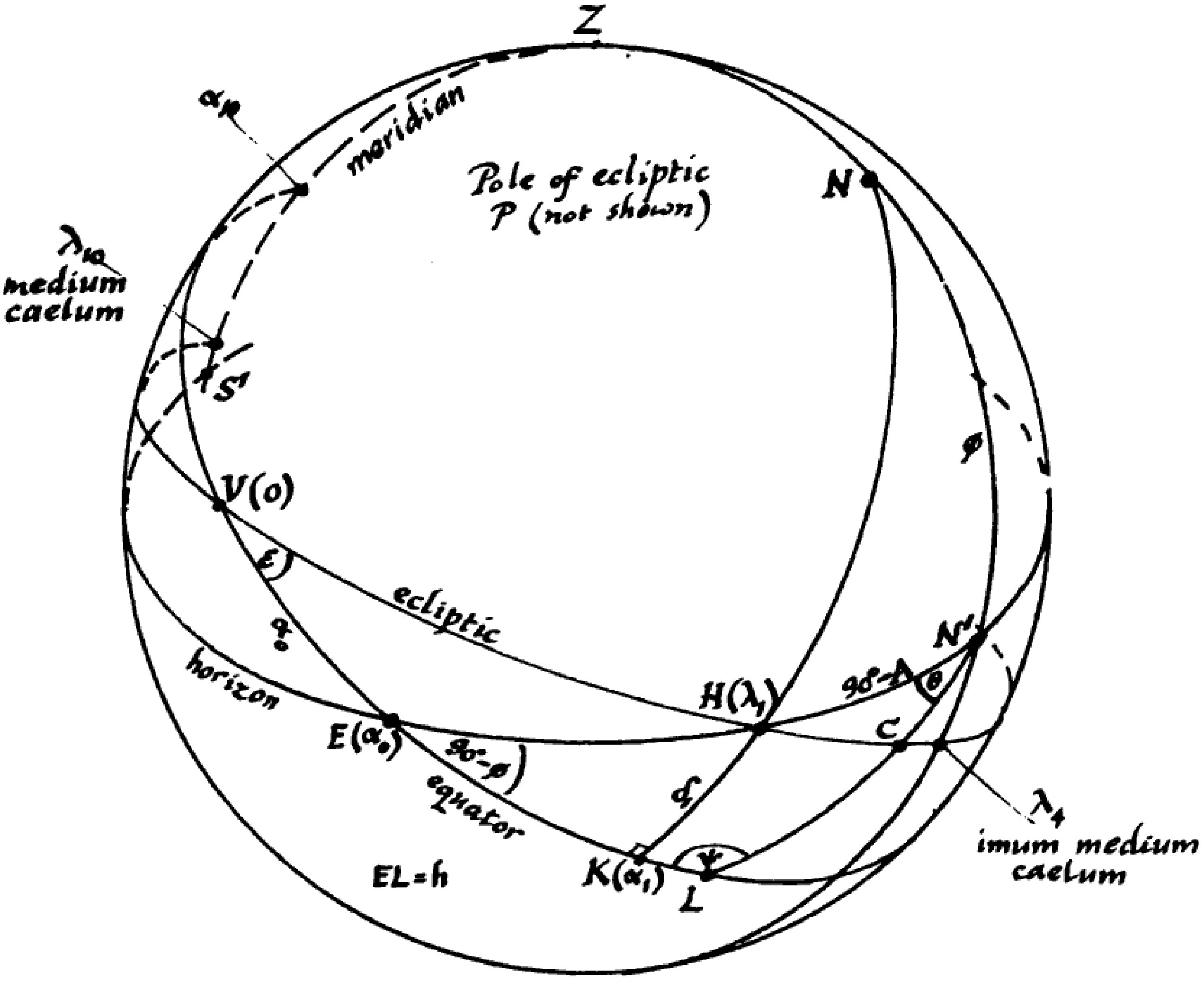

Fig. 2 The general configuration of the celestial sphere, showing the ecliptic, horizon, meridian, and celestial equator. The notation of this diagram (for which see p. 2) will be adhered to throughout this work.

1.2. *Some basic formulae*

I shall begin my account by giving a reasonably comprehensive list of formulae on which to draw subsequently. By far the most common procedure in use in the middle ages, as we shall see, was to divide each of the four main ecliptic arcs (themselves separate at the 'angles', of longitudes λ_1, λ_4, λ_7 and λ_{10}) into *arcs with equal rising times*. Since rotation of the system equator-plus-ecliptic is around the celestial poles, the horizon being regarded as fixed, this is equivalent to ensuring that

$$\alpha_2 = \alpha_1 + P/3 \qquad \alpha_8 = \alpha_7 + P/3$$
$$\alpha_3 = \alpha_1 + 2P/3 \qquad \alpha_9 = \alpha_7 + 2P/3$$

$$\alpha_5 = \alpha_4 + Q/3 \qquad \alpha_{11} = \alpha_{10} + Q/3$$
$$\alpha_6 = \alpha_4 + 2Q/3 \qquad \alpha_{12} = \alpha_{10} + 2Q/3,$$

where

$P = \alpha_4 - \alpha_1 = \alpha_{10} - \alpha_7$, and $Q = \alpha_7 - \alpha_4 = \alpha_1 - \alpha_{10}$.

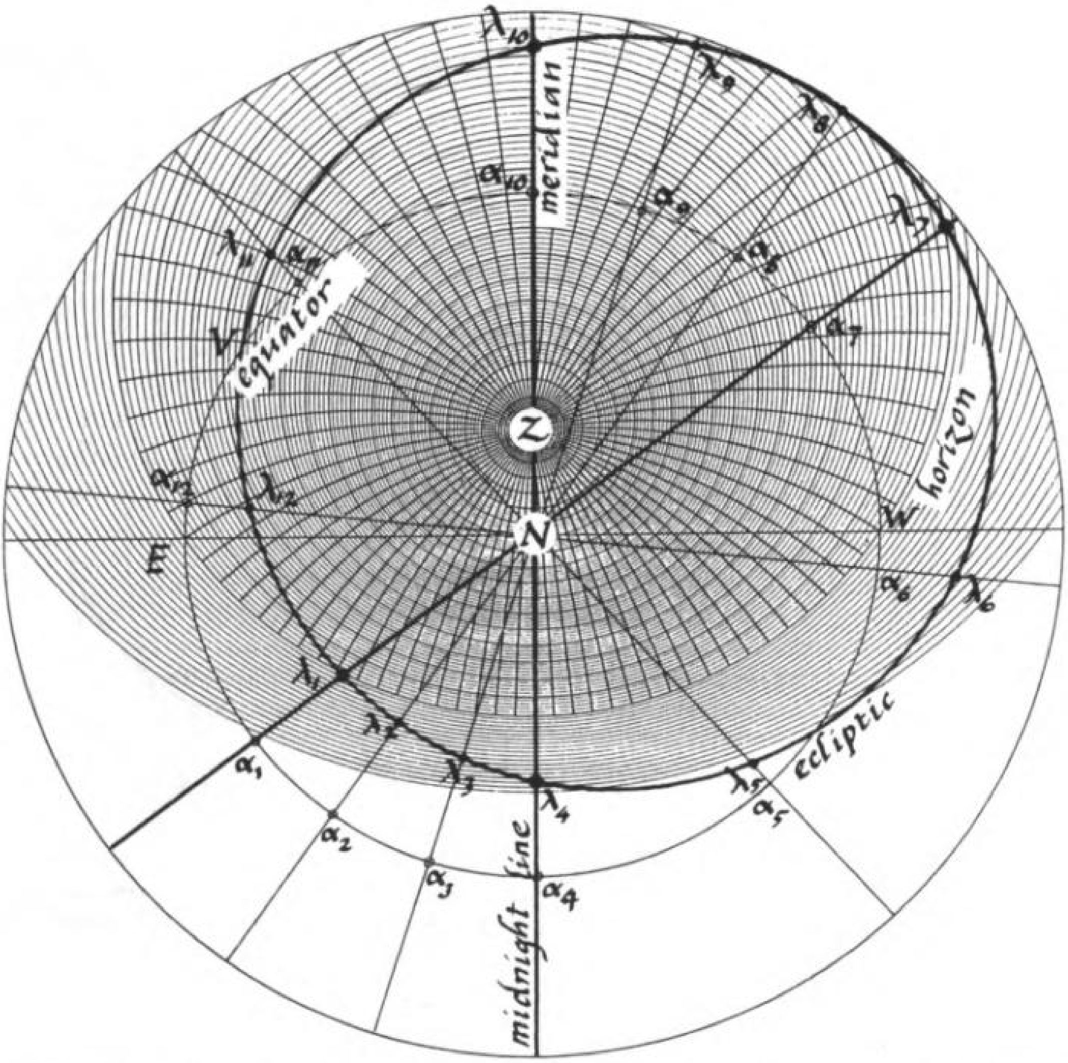

Fig. 3 A plane projection of the celestial sphere, showing the division of the houses in what was the most common medieval scheme. (In fact the projection is stereographic, as found on most ordinary planispheric astrolabes.) The straight lines radiating from N, the north pole, represent great circles, and those through the points marked λ_1 and λ_{10} (the ascendent, and mid-heaven, respectively) provide the key to the construction of the others, which trisect the angles between the former. The network of coordinate lines in the background is not an essential part of the diagram, but it may be used to give some idea of the altitudes (the lines of constant altitude are the complete circles) and azimuths (the azimuth lines radiate from Z, the zenith point) of the various points in the diagram.
The azimuth lines stop at the horizon, while the lines of constant altitude (called almucantars) traditionally continue for some way below. This has to do with twilight calculations. The stereographic projection shown here is for a latitude of 56° (Aarhus, Edinburgh, Moscow).

The longitudes are not uniformly spaced in the same way as the right ascensions, although there is symmetry in both coordinates about the centre, so that once the first three and the last three houses are calculated, the rest follow at once ($\lambda_n = \lambda_{n+6} - 180°$, just as $\alpha_n = \alpha_{n+6} - 180°$).

The method of division here outlined was often ascribed to 'Alchabitius' in the late middle ages, but it is far more ancient, and I shall henceforth simply refer to it as the *Standard method*. The first eight of the following formulae are of use in connection with it.

The last four will be needed when we come to two later methods, one commonly ascribed to Campanus, the other to Regiomontanus. In them, N′L is an arc of a typical great circle dividing the ecliptic into houses, M being a typical cusp. Six great circles are needed, all passing through N′ and S′, the horizon and meridian circles being two of the six. According to the 'Campanus' method, the six great circles are symmetrical, so that the sphere is like an orange divided into twelve equal segments (the angles θ at N′ and S′ taking on the values 30°, 60°, 90°, etc). According to the Regiomontanus method, it is the intercepts h (= EL) on the equator that take on these equal values, i.e. in steps of 30°. It is important to realize that the set of four cardinal 'angles', the cusps at the beginning of the first, fourth, seventh, and tenth houses, namely $\lambda_1, \lambda_4, \lambda_7$, and λ_{10}, will be *the same on all three systems* so far explained.

Here, then, are the formulae, given in modern notation:

(1) $\sin\delta_1 = \sin\lambda_1 \sin\varepsilon$ [s.r. in VHK][10]
(2) $\tan\alpha_1 = \tan\lambda_1 \cos\varepsilon$ [f.p.f. in VHK]
(Similiarly $\tan\alpha_n = \tan\lambda_n \cos\varepsilon$ for all *n*.)
(3) $\sin(\alpha_1 - \alpha_0) = \tan\delta_1 \tan\phi$ [f.p.f. in EHK]
(4) $\sin\alpha_1 = \tan\delta_1 \cot\varepsilon$ [f.p.f in VHK]
(5) $\sin(\alpha_1 - \alpha_0) = \tan\varepsilon \tan\phi \sin\alpha_1$ [from (3) and (4), $\delta_1 \neq 0$]
(6) $\sin A = \dfrac{\sin\varepsilon \sin\lambda_1}{\cos\phi}$ [s.r. in VEH]
(7) $\cos\alpha_0 \cos\varepsilon = \sin\alpha_0 \cot\lambda_1 + \sin\varepsilon \tan\phi$ [f.p.f. in VHF]
(8) $\dfrac{\sin(\lambda - \lambda_1)}{\sin\lambda} \dfrac{\sin(\alpha_0 + h)}{\sin h} \dfrac{1}{\cos A} = 1$ [Menelaus, in VEH/LCN′]
(9) $\mathrm{cost}\,\psi = -\cos h \tan\phi$ [f.p.f. in EN′L]
(10) $\cos(\alpha_0 + h)\cos\varepsilon = \sin(\alpha_0 + h)\cot\lambda - \sin\varepsilon \cot\psi$ [f.p.f. in VLC]
(11) $\tan\theta = \tan h \cos\phi$ [f.p.f. in EN′L]
(12) $\tan\lambda = \sin(\alpha_0 + h)/\{\cos(\alpha_0 + h)\cos\varepsilon - \cos h \tan\phi \sin\varepsilon\}$ [from (9) and (10)].

It is well known that, at least in Europe during most of the period under discussion, the solution of problems in spherical astronomy was still often done on the basis of Menelaus' theorem for a complete (spherical) quadrilateral, with chords preferred to sines, and the merits of the tangent function as a ratio of sine and cosine unknown. The resulting differences of expression and procedure do not, of course, entail intrinsically different formulae, although there is for us here a danger: one of those formulae might have been used to establish a table, which might then have been used with a table based on another formula *with a different basic parameter* (usually ε is under suspicion). It is in principle possible to throw up a simple formula which was, historically, obtained in two steps, which are for this same reason (incompatible parameters) inconsistent. Tangents are particularly dangerous functions to bandy about indiscriminately, for they might have made their first appearance historically within an authentic 'Hindu' tradition (as shadow lengths, say to a gnomon of twelve parts – but that is no problem), or they might be simply our own expression for a quotient of a sine and cosine, an abbreviation with a different justification. One can only take each case on its own merits, and where necessary – and this we shall do – represent incompatible tables with the help of formulae using different values of the obliquity – say ε_1 and ε_2.

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[10] The standard formulae of spherical trigonometry are here taken for granted. (See, for example, North (1976), vol. iii, pp. 142–54.) On the extent to which it is justifiable to use a 'modern' formula to represent ancient working, see the remarks below. Here I abbreviate 'by the application of the sine rule in spherical triangle VHK' to 's.r. in VHK', while 'f.p.f.' refers here to the four-parts formula, so called.

1.3. *Early practice. Determining the cardinal angles*

The usual way of approaching the historical problem, namely through astrological handbooks, can give a very misleading idea of actual practice, as may be seen from a study of the examples of Greek horoscopes provided by Neugebauer and van Hoesen.[11] Out of 168 horoscopes, from a period of nearly seven centuries (71 B.C. to 621 A.D.), only twenty-seven give an indication of both the ascendent and either mid-heaven or lower mid-heaven. Of these, only *two* include the limits of the twelve houses (*loci*). One of these two follows the method I am regarding as standard, namely based on symmetry of rising times (see the formulae on p. 13 above), apart from a shift of the houses proper through 5°. I alluded to this convention earlier. The horoscope is by Rhetorius.[12] The astrologer responsible for the other horoscope[13] settled the four cardinal angles correctly (horoscope, mid-heaven, etc.) and then simply divided each quadrant into three arcs of equal ecliptic *longitude*, thus escaping a certain amount of hard work. According to E. S. Kennedy, the houses were frequently found in this way in Islam.[14] As for Rhetorius, he explained his procedure carefully, for the most part. The houses, defined as I defined them earlier, could be called the 'geometrical houses' (for the case he gives we should then write $\lambda_1 = 55;16°$, $\lambda_{10} = 303;37°$ for example), in contrast with the houses he finally accepts (with cusps at 50;16°, 298;37°, and so on). Ptolemy was his authority for the 5° shift.[15] It is interesting to see that Rhetorius was puzzled by the fact that the culminating point corresponding to $\lambda_1 + 5°$ is not equal to $\lambda_{10} + 5°$.

The other horoscope mentioned above, which is for a date in A.D. 497, is associated with a diagram, redrawn as (a) in Fig. 1, and reproduced in section II.1 below. In style it resembles, (b), but it lacks the bounding square. It differs from typical type (b) figures in the way in which the cusps of the houses are recorded.[16] Diagrams, it seems, are rare in papyri but not in Byzantine codices.

The classification of these two horoscopes will be postponed, for the time being. (Nine Greek horoscopes will be examined more closely in section II.1 below.) Out of twenty-seven cases where the cardinal angles λ_1 and λ_{10} were properly related, four, all of them early (original sources for A.D. 15, 46, 81, and a literary source for B.C. 71) were drawn up by astrologers who took the easy way out, and supposed mid-heaven to be just three signs removed from the ascendent. What I shall later call the Single Longitude method is that which gives precisely 30° to each house, and which often regards the cardinal points to be spaced at 90° intervals and yet on the horizon and meridian. This was the method presented, in fact, in an enormously popular text-book of astrology – the comprehensive fourth-century *Matheseos* of Firmicus Maternus (II.19). Oddly enough, the method had a new lease of life in the sixteenth century, as we shall see. As for the Greek horoscopes recorded by Neugebauer and van Hoesen, only two out of the fifty-one non-literary examples (for A.D. 95 and 137) include a calculated degree for mid-heaven. It seems likely that the average astrologer found the exercise a difficult one.[17] If, as Neugebauer and van Hoesen seem to imply, one of these two (that for A.D. 95) is poorly calculated, our suspicion is reinforced.

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[11] Op. cit. (1959).

[12] Number L.428 (literary source for the year 428 A.D.). Original documents are similarly numbered by year, but now without any prefix.

[13] Number L.497.

[14] Kennedy (1956), p. 144.

[15] The reference is *Tetrabiblos*, ed. Robbins, III.10, and ed. Boll-Boer, III.11.

[16] The left-hand centre square represents the first house (as on most but not all Western horoscopes), but the longitude of the cusp is written above its upper edge – and so for the other houses, still proceeding in a clockwise sense. This way of treating the lines as house divisions is obviously more logical than the alternative.

It seems, therefore, that Greek astrologers did not attach such importance to the houses as later Islamic and Christian astrologers were to do. Surviving Greek horoscopes are unevenly distributed in time, with the second and fifth centuries well represented (the former especially through Vettius Valens) no doubt as a result of accidents of preservation. In character, when the horoscopes are interpreted at all, they tend to be retrospective and confirmatory, rather than predictive. Many of the doctrines they put into practice are mathematically highly convoluted, but as far as even the four cardinal angles are concerned, only one in seven gives evidence that the calculation was thought to matter. Rhetorius was responsible for one of a total of only six horoscopes where mid-heaven was given to minutes of arc, and it is interesting to see that he contrasted the rising times tabulated by Ptolemy, accurate to minutes, with the cruder schemes of the Egyptians and Valens.[18] It is worth noticing here that Vettius Valens, with over fifty examples to his name, calculated them for subjects from a wide range of terrestrial latitudes, between the first and the seventh climate.

The Rhetorius horoscope had a curious later history, for as D. Pingree shows,[19] the planetary configuration it represents was taken over by Māshā'allāh,[20] the eighth-century Jewish astrologer, and reported by his pupil Abū ʿAlī al-Khayyāt. The cusps of the houses were not taken over. Not only are his different, but they are calculated for different latitudes.[21] It sems that Māshā'allāh, when drawing on such earlier Greek sources, was prepared to make use of horoscopes calculated with Greek tables of ascensions, but that in his own astrological world history he worked to the rough principle of one house per zodiacal sign, naming the precise degree only in the case of the ascendent.[22]

Although the tradition of accurate house division was evidently slow in gaining acceptance, the key to the calculation had been available to the Babylonians. One must be able to find λ_{10} for a given λ_1 – and this is essentially the problem of rising times of the signs of the zodiac. First, some terminology: the 'oblique ascension' of the point H of longitude λ_1 (see Fig. 2) is the right ascension α_0. The vernal point V rises at E, and the point of the ecliptic of longitude λ_1 rises when the sphere has turned around the poles through angle α_0. In other words, the oblique ascension α_0 is the angle equivalent (at a rate of 360° per 24 sidereal hours) to the rising time of the ecliptic arc between V and H.

The Babylonians gave the rising times of the signs of the zodiac, not precisely, on the basis of observation, but so as to fit conveniently into an arithmetical progression with extrema in the ratio 3:2, their local ratio for longest to shortest daylight.[23]

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[17] The correct solution to the problem of finding the longitudes of mid-heaven and ascendent had been given in Ptolemy's *Almagest*, II.9. For arithmetical schemes, see n. 23 below. Firmicus Maternus (*Matheseos*, II.11) had some very rough and ready tables of ascensions. He was certainly not entirely unaware of the general problem. Bouché-Leclercq has a number of useful references to astrologers' ways of dealing with it in his (1899), pp. 256 ff. Note his remarks about Manilius, 'médiocre élève d'Uranie, [qui] n'a fait que traverse les mathématiques sur le dos de Pégase' (p. 267 n.1).

[18] Neugebauer and van Hoesen (1959), p. 188, n. 71.

[19] Kennedy and Pingree (1971), pp. 173, 162.

[20] In the *Kitāb al-mawalid*, now known only in a Latin translation.

[21] See p. 74 below.

[22] The work, 'On conjunctions, religions, and peoples', survives only in part, and that in an Arabic version, with interpolations. It is possible that the house divisions have been suppressed.

[23] If M is the longest daylight (in degrees) then the constant difference beween the rising times of successive

Finding α_0 is obviously the key to our problem, on the assumption that we have a means of converting ecliptic arcs into equatorial arcs, and conversely, for α_{10} is simply 90° removed from α_0. Ptolemy's approach was through the 'ascensional difference' $(\alpha_1 - \alpha_0)$, where α_1 is easily found from λ_1 (cf. my equation (2)). In medieval western astronomy ascensional differences were occasionally, following Islamic practice, called 'equations of daylight', a fact that reflects on Ptolemy's relation between them and longest daylight. If the Sun were at λ_1, its diurnal arc D (i.e. above the horizon, geometrically considered, regardless of refraction) would be $180° + 2\ (\alpha_1 - \alpha_0)$. From equation (3) above, therefore,[24] writing the Sun's declination as δ,

$$(13) \quad -\cos\frac{D}{2} = \tan\delta\tan\phi.$$

For maximum diurnal arc (M), the Sun is at maximum declination $\delta = \varepsilon$:

$$(14) \quad -\cos\frac{M}{2} = \tan\varepsilon\tan\phi.$$

This is equivalent to Ptolemy's method for M. Minimum daylight is when $\delta = -\varepsilon$. The *Handy Tables* of Theon have a table correlating ϕ with $M - 12^h$ (M converted to hours).[25] Ptolemy's division of the Earth's surface into climates (*Almagest,* II.8) is by lengths of longest day, the first climate beginning where the longest day is $12^h\,30^m$ ($\phi = 8;25°$) and ending where it is $13^h\,00^m$ ($\phi = 16;27°$), the second ending where it is $13^h\,30^m$ ($\phi = 23;51°$), and so on, with half hour increments. Accurate horoscopes based on Ptolemy's tables of ascensions (or others following their implicit parameters) may be expected to reveal the fact, unless interpolation was used, through the special values they imply for ϕ.[26]

We know that not all astronomers after Ptolemy, let alone before, used his precise approach to these ascensional problems. Manilius, early in the first century, provides us with evidence of a confused situation. As Neugebauer explains, Manilius, despite his claim to be the inventor of some arithmetical rules for rising times, gives examples that sometimes refer to Alexandria (using Babylonian System A), sometimes to Babylon, and sometimes to Rome (Babylonian System B), without informing the reader of any change of basis.[27] Ptolemy knew the arithmetical rules, and criticized them in *Tetrabiblos,* but the System A rising times were used by astronomers as far apart as Bardesanes of Edessa (ca. 200 A.D.) and Varāha Mihira (sixth-century India). System B is found not only in Manilius and a second-century Greek papyrus, but even in a Gerbert reference to Martianus, and an eleventh-century example repeated in the translation by Gerard of

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signs was taken as either one ninth part (System A) or one twelfth part (System B) of $M - 180$. Shortest daylight is $360° - M$, and the 3:2 condition thus implies that $M = 216°$ and that the steps are of 4° (System A) or 3° (System B). There is obvious symmetry: the six rising times for the different signs are (Aries to Virgo, and Pisces to Libra) 20°, 24°, . . . 40° (A) and 21°, 24° . . . 39° (B). The longest day will be the total of the last three rising times, taken twice over, i.e. when the Sun is at the beginning of Cancer the six northern signs will rise in the course of the day. See Neugebauer and van Hoesen, op. cit., pp. 3–5 and 9–10, where they note that the arithmetical scheme implies that at the equator ($M = 180°$) all zodiacal signs rise in equal time.

[24] See p. 5 above. I shall refer constantly throughout the book to these early equations by their numbers, without further page references.

[25] For specimen entries see Neugebauer (1975), p. 980. Although evidently derived following the method of *Almagest,* there is no equally long table there. There is a shorter one at I.6.

[26] I list all relevant values of ϕ for reference, from *Almagest* II.8: 8;25°, 16;27°, 23;51°, 30;22°, 36;00°, 40;56°, 45;01° 48;00°, 51;30°, 54;01°. In what follows there are further references to the climates, and it must always be remembered that *their limits always depend on the value assumed for the obliquity of the ecliptic.*

[27] See Neugebauer (1975), pp. 718 ff., for more information on this, and the remainder of the paragraph. Cf. n. 23 above.

Cremona. We shall later have occasion to examine a related scheme from the twelfth century.

Lack of precision might of course have come about in many ways. The late fourth-century writer Paulus Alexandrinus, for example, gave a rule for calculating mid-heaven, amounting to $\lambda_{10} = 270^\circ + \alpha_0$. This rule implies that no distinction is being made between longitude and right ascension (since $\alpha_{10} = 270^\circ + \alpha_0$).[28] On the question of approximation rather than straightforward error, note especially the use of astrolabes and planispheric devices generally. The determination of rising times was one of the two principal uses Ptolemy had in mind when composing his *Planisphaerium*, and in the middle ages one finds tables of the houses expressly compiled with the help of an astrolabe.[29]

1.4. *From rising times to the Standard method for the houses. Various sorts of table*

The connection between the Standard method of casting the houses and the geometry of rising times is easily seen. Tables correlating λ_1 with α_0 (or $(\alpha_1 - \alpha_0)$, or the semi-diurnal arc) may obviously be used for the geometrical problem, whether or not the Sun happens to be at ecliptic longitude λ_1. A typical procedure for finding λ_2, λ_3, etc, for given λ_1 might be as follows. Here 'T(a,b)' denotes a table where *b* is the function and *a* the argument.

(i) Enter $T_1(\lambda_1, \alpha_1)$ with given λ_1, to find α_1.[30]
(ii) Enter $T_2(\lambda_1, \alpha_0)$ with given λ_1, to find α_0.
(iii) Form $\alpha_2 = \alpha_1 + (90^\circ + \alpha^0 - \alpha_1)/3$
$\alpha_3 = \alpha_1 + (90^\circ + \alpha_0 - \alpha_1)/3$
$\alpha_{12} = \alpha_1 - (90^\circ - \alpha_0 + \alpha_1)/3$
$\alpha_{11} = \alpha_1 - 2(90^\circ - \alpha_0 + \alpha_1)/3$
$\alpha_{10} = \alpha_1 - (90^\circ - \alpha_0 + \alpha_1)$.
(iv) Enter the body of the table T_1 with each of these values of α successively, and find, by interpolation where necessary, λ_2, λ_3, λ_{13}, etc. If mid-heaven only is required, enter with $\alpha_0 - 90^\circ$ to find λ_{10}.

Another procedure uses a table for the semi-diurnal arc D/2:

(i) As before, using T_1.
(ii) Enter $T_3(\lambda_{sun}, D/2)$ with λ_1, to find $90^\circ - \alpha_0 + \alpha_1$ (immediately) and $90^\circ + \alpha_0 - \alpha_1$ (as its supplement).
(iii) Form α_2, α_3, etc., as before.
(iv) As before, using T_1.

The tables needed here are available in several trivially variant forms. T_1 appears under various names (table of ascensions at *sphaera recta*, table of the elevation of signs at the direct circle, table of right ascension, table of the horoscope of the signs for the land of Arin, etc.),[31] but more to the point are these two conventions: according to the first, α_1 is given immediately as a function of λ_1; according to the second, $\alpha_1 + 90^\circ$ is given as the tabulated function of λ_1. On this second convention, since $\alpha_0 = \alpha_{10} + 90^\circ$, and since entering the table with λ_{10} gives us $\alpha_{10} + 90^\circ$, therefore here we have a table (say T'_1) *that gives the oblique ascension as a function of the longitude of the culminating point of the ecliptic.* The main function of this table, though, was to relate longitudes and right ascensions.

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[28] Cf. Fig. 2, as well as Neugebauer and van Hoesen (1959), p.10. For a key to various opinions as to Ptolemy's intentions, see Appendix 1 below.

[29] Thus among the Toledan tables in a 14th-century French MS, now Bodleian Library, MS Canon misc. 556, f. 51v, there is one for the latitude 48 (Paris). In view of the Parisian connection, it is pertinent to mention an anonymous Parisian astronomer of 1290 who repeatedly alludes to his having used an instrument to verify similar computations. See F. Pedersen (1984), pp. 173 and 186.

[30] Or $\alpha_1 + 90$. See below.

[31] The meanings of the phrases are evident when it is realized that for an observer on the equator (*sphaera recta*, *circulus directus*, etc.) the poles N and S will lie on the horizon, and K and E (Fig. 2) will coincide, so that $\alpha_0 = \alpha_1$. The name mentioning Arin alludes to the place on the equator on the zero meridian in the Hindu tradition (Arin = Ujjain), and when it is found in western sources it usually indicates influence from the tables of al-Khwārizmī.

Turning back to our earlier equations, we can see that T'_1 and T_1 must be based on equation (2), or its equivalents. As important examples of such tables we find:

(a) Type T_1 in *Almagest*, II.8; λ_1 in steps of 10°; α_1 in degrees and minutes; based on $\varepsilon = 23;51^\circ$.
(b) Type T_1, fragment, in P.Lond. 1278.[32]
(c) Type T_1, in the *Handy Tables*; λ_1 in steps of 1°; $\alpha + 90^\circ$ in degrees and minutes; based on $\varepsilon = 23;51^\circ$.[33]
(d) Type T_1, in al-Khwārizmī's tables (c. 840 A.D.); λ_1 in steps of 1°; $\alpha + 90^\circ$ in degrees, minutes and seconds; based on $\varepsilon = 23;51^\circ$.[34]
(e) Type T_1, in al-Battānī's tables (c.900 A.D.); λ_1 in steps of 1°; $\alpha + 90^\circ$ to minutes only based on $\alpha = 23;35^\circ$.[35] The same table is found among the Toledan tables.[36]

We shall consider medieval Western examples at a later stage. Among the numerous Islamic zījes outlined by E. S. Kennedy, most seem to follow the T'_1 convention (an addition to Kūshyar, 1000 A.D.; al-Khāzinī, c. 1120; Nasīr ad-dīn aṭ-Ṭūsī, c.1240; Ibn ash-Shāṭir, c.1350; Jamshīd al-Kāshī, c. 1420; and Ulugh Beg, are the most notable). A few are to be found faithful to the T_1 convention (Yaḥya ibn Abī Manṣur, C. 810; Ḥabash al-Ḥasib, c. 850; Kūshyar's original table; and table in Ulugh Beg).

Tables of type T_2 (λ_1, α_0), needed in the second stage of the procedure for casting the houses by the Standard method, inevitably occur in a greater variety of forms. Each table is of course latitude-dependent, in a way easily seen from equation (7), which does not, however, lend itself to an easy solution for α_0. The route to a table of oblique ascensions for a particular latitude was through a pair of equations (or more, taking their historical components) such as (2) and (5), or (1), (2) and (3).[37] The most important early examples of the resulting tables are, for our purposes:

(a) Those in *Almagest*, II.8; λ_1 in steps of 10°; α_0 to minutes; based on $\varepsilon = 23;51^\circ$; for ten latitudes.[38] (P.Lond. 1278 has the tables to the same convention, but for only the first two climates.)
(b) *Handy Tables*; λ_1 in steps of 1°; α_0 to minutes; based on 23;51° for seven climates between $\phi = 16;27^\circ$ and 48°, inclusive,[39] and an extra table for Byzantium ($\phi = 43;35^\circ$).[40]
Al-Battānī, for Raqqa ($\phi = 36^\circ$); λ_1 by 1°; α_0 to minutes; $\varepsilon = 23;35^\circ$. Also tables with λ_1 in steps of 10°, for places of maximum daylight between 13^h and 16^h, by 15^m intervals; and for $\phi = 21;40^\circ$ (Mecca), 33;9° (Baghdad) and 36;40° (Ḥarrān).[41]
(d) Toledan tables; λ_1 by 1°; α_0 to minutes; based on $\varepsilon = 23;33,30^\circ$ for Toledo (ϕ =

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[32] See Neugebauer (1958), pp. 93–113.

[33] Ptolemy (Halma, ed. 1822 etc.), part 1, pp. 148–55.

[34] Table 59–59b in al-Khwārizmī (Suter, ed., 1914); cf. Neugebauer (1962), pp. 104–5.

[35] Al-Battānī (Nallino, ed., 1903, etc.), vol. ii, pp. 61–4.

[36] Toomer (1968), pp. 34–5.

[37] The latter set represents the procedure of *Almagest*, II.7. See below.

[38] Cf. n. 26 above.

[39] Ptolemy (Halma, ed., 1822, etc.), vol. ii, pp. 2–57.

[40] Ibid., pp. 58–65.

[41] Al-Battānī (Nallino, ed., 1903, etc.), pp. 61–71.

39;54°).[42] There is also a table for Cremona ($\phi = 45°$), presumed added by the translator, Gerard of Cremona, and evidently based on $\varepsilon = 23;51°$.[43]

Note that although chapter 32 of al-Khwārizmī shows that he envisaged the use of a table of seasonal hours for drawing up full tables of the house,[44] neither this nor any table of oblique ascensions is included in the extant collection. The early Islamic zījes do have tables of type T_2 (λ_1, α_0), these being usually for seven climates only, plus one for the local latitude, and perhaps a few other places of importance. According to E. S. Kennedy, beginning with Ibn Yūnus (d. 1009) a trend established itself for computing tables at 1° intervals of ϕ up to some suitably high latitude. Ibn Yūnus' own tables went from $\phi = 1°$ to 48°. D. A. King notes that according to Manṣūr ibn 'Irāq (died c. 1036) no one north of 48° 'studies this sort of thing or even thinks about it'.[45] This was not then far from the truth, but within a century or two the situation would change appreciably.

Tables of type T_3 (λ_{sun}, D/2), or their near equivalents, such as tables for the lengths of daylight (in hours and minutes), or tables of seasonal (unequal) hours, are only marginally less common than tables of oblique ascensions.[46] The *Handy Tables* tabulate the lengths of the seasonal hours alongside the oblique ascensions, that is for integer degrees of λ_1. Al-Khwārizmī had none, but in his chapter 32 (cf. chapter 27) he explained how to obtain the daylight hours from his tables of oblique ascensions, now lost. Daylight tables are found in the zījes of Yaḥyā ibn Abī Manṣūr, al-Khāzinī, Nasīr ad-dīn aṭ-Ṭūsī and Ibn ash-Shāṭir. Tables of seasonal hours are in the first, third and last of these, and in Kūshyar. Neither sort is in al-Battānī – a fact to be mentioned since he was so very influential in the West. The 'Toledan' tables for oblique ascensions (*elevationes signorum*, T_2 above), for both Toledo and Cremona, contain columns giving the seasonal hours (*equaciones horarum*[47] or *partes horarum*) but in angular measure (degrees and minutes).

This 'partes horarum' column reappears often in western manuscripts, and its significance is worth noting. It gives one sixth part of the semi-diurnal arc D/2, namely $(90° + \alpha_1 - \alpha_0)/6$. Since the adjacent column (Tables T_2 and T_3 run parallel) contains α_0, it is a simple matter to use the two together to reconstruct the table of type T'_1 (or T_1) that was used in its construction. I have done this for both the Toledo and the Cremona versions of the (T_2, T_3) pair, and find that neither is particularly well calculated, in the sense that for each pair there is a good deal of scatter around consistent values (i.e. values computed for any one value of the obliquity). Since there is little to choose between the two pairs, it seems that the fault might lie with the table of right ascensions used in their construction. Since the arithmetic means of values of ε deduced from the tables are 23;32,32° (Toledo) and 23;33,21° (Cremona), with standard deviations of 0;13,38° and 0;19,56° respectively,[48] it seems likely that both tables were based in part on a table (now lost)[49] for $\varepsilon = 23;33,30°$ or perhaps 23;33°, the former figure occurring in the Toledan canons ascribed to Ibn az-Zarqellu ('Azarchel'), the latter mentioned in other Toledan contexts, but typical of ninth-century Islamic determinations.[50]

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[42] Toomer (1968), p. 36.

[43] Ibid., p. 27.

[44] See section I.5 below.

[45] DSB (1976), vol. xiv, p. 577.

[46] Another near equivalent is a table of ascensional differences, here treated separately.

[47] So called in Bodleian Library, MS Laud misc. 644, ff. 37r–40v, and not to be confused with *equacio dierum*, the equation of time, quite a different function.

[48] Based on equation (2) above and the Laud misc. MS, with rejection of obviously erroneous values and values for λ_1 within ten degrees of 0° and 180°.

[49] Remember that the Toledan value of T_1' is simply al-Battānī's, with an obliquity of 23;35°.

[50] A passage in the Azarchel canons in the MSS used by Millás Vallicrosa holds 'Iahie ben abi Almansoris' responsible for determining a value of 23;33°. G. J. Toomer (1968), pp. 30–31, notes that E. S. Kennedy records a zīj ascribed to

As an example of a simple inference as to the obliquity implicit in a statement of the longest day, for a given latitude, consider the case recorded in a table of unequal hours in MS Laud misc. 594 (f. 84r). There the longest day for Oxford, with latitude given as 51;50°, is said to be $16^h29^m33^s$. Referring to my equation (3), this means that when $(\alpha_1 - \alpha_0)$ corresponds to a half of $4^h29^m33^s$, the declination equals the obliquity. This is easily found as 23;33,30°, the 'Toledan' figure once more.

The two methods earlier outlined for finding the cusps of the houses may be supplemented with a third, where in the second stage a table of *ascensional differences*, T_4 $(\lambda_1, \alpha_1 - \alpha_0)$, is used to form the series of right ascensions. Ptolemy's way of deriving ascensional differences, explained in *Almagest*, II.7, was from a relation equivalent to equation (3):

$$(3) \quad \sin(\alpha_1 - \alpha_0) = \tan\phi \tan\delta_1,$$

taken in conjunction with the equivalent of equation (1) for δ_1:

$$\sin\delta_1 = \sin\lambda_1 \sin\varepsilon.$$

From these, individual tables were drawn up, as we have seen, for closely related functions (such as daylight and seasonal hours) for very many different latitudes. It was obviously desirable to have a table that could be used by an astronomer at *any* place on the Earth, and we know that al-Khwārizmī had just such a table, which might be the 'tabula differencie ascensionum universe terre' still extant in the Toledan tables.[51] Whether or not this is so, there is yet another plain inconsistency in the inclusion of a table of this type, calculated for $\varepsilon = 23;51,00°$, in the same collection as a double table of oblique ascensions and seasonal hours for $\varepsilon = 23;33,[30?]°$.

This is a suitable point at which to introduce *a method for analysing a table of type* T_2 (λ_1, α_0), for oblique ascensions. From a consideration of our equation (7) in section I.2 above, it is obvious that we may write this as

$$y = mx + c,$$

where $x = \cos\alpha_0$, $y = \sin\alpha_0 \cot\lambda_1$, and m and c are *constants* for a particular table. This we may do *if we are prepared to overlook complications arising from the use of incompatible tables*. Here $m = \cos\varepsilon$, and $c = -\sin\varepsilon\tan\phi$. Using ordinary methods of numerical analysis, m and c may be found from two or more pairs (x,y). This allows us to deduce both ε and ϕ.

It is possible to shorten the analysis in principle. The tables do not (since λ_1 is the argument) have an entry for $\alpha_0 = 90°$ precisely, but such can be found by interpolation. If L is the value of λ_1 which corresponds to $\alpha_0 = 90°$, then $c = \cot L$.

Although without a full statistical analysis, four tables will be analysed here on the basis of two pairs of (x,y) values in each case, supplemented by interpolated values for L, and consequent derivation of additional values for c. The first table (A) is a Toledan table (of type T_2, as are all these) which is said to be for latitude 48° precisely. The other three tables are out of a manuscript discussed in II below, and are said to be for latitudes 48;16°, 32;55°, and 52;19° respectively. None of this information as to latitudes will be presupposed. To save space, one of the pairs of entries used in each case for interpolation is used for the first method.

Yaḥyà ibn Abī Manṣur (c.810) with a declination table based on this value precisely. See Kennedy (1956), p. 145. He does not say whether the table for right ascensions in the same zīj is based on the same value.

[51] Toomer (1968), p. 33.

	λ_1	α_0	x	y	m	−c	ε	φ
A	45	23;06	0.91982	0.39234	0.91404	0.44842	23;56	47;55
	114	89;48	0.00349	−0.44523		0.44837		ditto
	114;09(L)	90						
	115	91;06						
B	45	23;17	0.91856	0.39528	0.91706	0.44709	23;30	48;16
	114	89;53	0.00204	−0.44523		0.44697		ditto
	114;05(L)	90						
	115	91;11						
C	30	20;19	0.93779	0.60138	0.91709	0.25866	23;30	32;58
	104	89;25	0.01018	−0.24932		0.25862		ditto
	104;30(L)	90						
	105	90;35						
D	30	12;38	0.97579	0.37882	0.91720	0.51616	23;29	52;20
	117	89;35	0.00727	−0.50953		0.51614		ditto
	117;18(L)	90						
	118	90;58	−0.01687	−0.53163				

The derived values for the obliquity and the latitude give a remarkably consistent picture, which would not, as it happens, have changed very much had a statistical method been used. Entries for $\lambda_1 = 30°$ and 45° were used only because of uncertainties as to manuscript reliability. We should not put too much weight on the obliquities, but the derived figures do clearly indicate that a Ptolemaic value was used in the Toledan table, and that this was certainly not the case for A, B, and C. There are several well known astronomers who used an obliquity of 23;30° (Naṣīr ad-dīn aṭ-Ṭūsī, c.1240. Maimonides, c.1174, for instance) and others with 23;31° or 23;32°. It is doubtful whether we have enough evidence here to rule out even 23;35°, let alone 23;33°. Suppose, however, we take the stated latitudes to be exact, and divide the tangent of each into the corresponding value of − c. (We may take the mean of our two values for c on each occasion.) This gives sin ε. The values for ε obtained in this way are as follows:

(A) 23;49°,
(B) 23;30°,
(C) 23;33°,
(D) 23;30°.

Here two out of the three again seem to indicate the value 23;30°. (For further details, see section II.)

One final observation: it will be seen from our equation (14) that the ratio of coefficients c/m is simply the cosine of M, the maximum semi-diurnal arc. Since M is often stated on tables of type T_2, this fact gives us another way of approaching the problem of origins.

1.5. *Al-Khwārizmī's universal table*

The canons to al-Khwārizmī's tables, and those of Ibn az-Zarqellu to the Toledan, explain the use (and in the first case, the design) of this universal table.[52] The explanation can be much simplified thus:

(i) Find u, the *umbra versa* for your latitude. (There is a shadow table giving the equivalent of 12 cot a, where a is the solar altitude, in al-Khwārizmī's, the Toledan, and many other medieval tables; here $u = 12 \tan \phi$).
(ii) Enter an as yet unexplained table T_5 with λ_1, and take out n.
(iii) Form nu. By searching in the appropriate sine table (i.e. one to a radius of 150 minutes)[53] to find the arc for which this is the sine, $(\alpha_1 - \alpha_0)$ is obtained.

In modern notation, the new table may be represented as $T_5\ (\lambda_1, \mathrm{n})$, where

$$\alpha_1 - \alpha_0 = \text{arc sin}\left(\frac{\mathrm{n}\ 12 \tan \phi}{150}\right).$$

Comparing this with (3), clearly $\mathrm{n} = \frac{25}{2} \tan \delta_1$. (The result will be in minutes.) It is a straightforward matter to extract the assumed obliquity, since for $\lambda_1 = 90°$ we have $\mathrm{n} = \frac{25}{2} \tan \varepsilon$. The universal table T_5 in the Toledan set is based on the Ptolemaic 23;51°, but in the so-called 'Almanac of Azarchel' there is one to the norm of $\varepsilon = 23;33,30°$.[54] It is surely not without significance that the Toledan sine table to a radius of 150′ occurs in parallel with a declination table to the Ptolemaic norm for the obliquity. This must reinforce doubts that either this pair or the universal table was of Ibn az-Zarqellu's making, although his name is often found attached to both in derivative works of the late middle ages, presumably because all the Toledan tables were so often simply treated as his.

1.6. *Comprehensive tables of houses and their analysis. The Libra zero test*

The last broad class of tables to be considered is one encapsulating all of the subsidiary techniques for the standard division of the zodiac into houses. It provides the longitudes of all the other cusps[55] as a function of one, usually the ascendent. It is obviously dependent on assumed latitude and obliquity, and since it might be based on several obliquity-dependent tables it might embody inconsistent values of ε. The tables going under the name of al-Khwārizmī include one for the houses (*Aequatio casarum duodecim signo Arietis,* and in the transcription of the day, *Tezwiet—elbuiut idhnascer liburug elhamel*), for no specified latitude,[56] and the same is found in the Toledan tables, where it is said to be for that city (*Equatio domorum ad signum Arietis super latitudinem civitatis Toleti*).[57] It gives the cusps to minutes of arc, for λ_1 in degree intervals. I am told by E. S. Kennedy that tables for equalization of the houses are not uncommon in zījes, and in his *Survey*, for example,

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[52] See especially the commentary to the Suter edition in Neugebauer's version (1962), pp. 50–55 (on chs 26 and 26a) and his references to Lesley (1957).

[53] The Suter/Khwārizmī sine table (58 and 58a) is to a radius of 60 parts, but al-Bīrūnī tells us that al-Khwārizmī used a radius of 150 minutes and the Toledan tables have such, as does the 'interlinear version', with which Neugebauer supplemented his commentary on Suter (for which see his (1962) pp. 189, 104; cf. Toomer (1968), pp. 27–9).

[54] Millás (1954–50), p. 225.

[55] Actually only six are tabulated in most collections of tables, since the distribution is symmetrical (see Fig. 3; $\lambda_{n+6} = \lambda_n + 180°$).

[56] Suter, ed., tables 79–90. He assumed Córdoba – but see below. (I follow here the spelling of his edition.)

[57] Toomer (1968), pp. 140–3.

Kūshyar has one to seconds of arc, while Naṣīr ad-dīn aṭ-Ṭūsī includes one, but only to seconds.

Al-Khwārizmī's text (chs. 32, 36, ed. Suter) explains the computation and use of the table of houses, but adds nothing to the principles already explained here. We have seen how an astronomer, following *Almagest*, might have incorporated into his table of houses equations equivalent to (1), (2) and (3). In al-Khwārizmī's case we should expect consistency (since his tables seem to have favoured 23;51° as the value for ε), but other astronomers might easily have incorporated *two, and even three*, values for the obliquity. The first could have happened if α_1 was derived essentially from (2), and $(\alpha_1 - \alpha_0)$ from (1) and (3). Here (1) and (2) involve ε, and might come from incompatible sources. The worse situation could have occurred if α_1 had come from (2) and α_0 from (1), (3), and a *different* embodiment (we are thinking of tables) of (2). These points have to be mentioned if one is to avoid condemning as 'badly calculated' a table that is merely based on incongruous components.

This problem will remain an obstacle to an accurate analysis of a single horoscope, but in the case of a table of houses there are two points ($\lambda_1 = 0, 180°$) at which equations (1) and (3) leave no trace on the tabulated longitudes for the cusps. (Otherwise expressed, the cusps are independent of ϕ, and if $\lambda_1 = \alpha_1 = 0$, then $\alpha_2 = 30°$, $\alpha_3 = 60°$, etc.) What is revealed is the table of right ascensions (T_1 or T'_1), or rather one of the possible two such tables, used in the task. Libra 0° is for obvious reasons the most useful test point, and I shall refer to this in future as the 'Libra zero test'.

The five remaining cusps in the table ascribed to al-Khwārizmī, when the first is $\lambda_1 = 0$ (taking the row for Virgo 30°, and adding six signs), are these:

$$\lambda_2 = 32;12° \qquad \lambda_3 = 62;07° \qquad \lambda_4 = 90°$$
$$\lambda_5 = 117;53 \qquad \lambda_6 = 147;47°.$$

There are here in principle only two independently useful values; but the first and last are not, as they should be, supplementary angles. To see how one minute of arc can mislead, we need only consider the values for ε obtained from λ_2 and λ_6, by equation (2), namely 23;32,06° and 23;37,10° respectively. From λ_3 and λ_5 we get 23;35,26°. This is evidence enough, one imagines, for supposing that al-Battānī's table of right ascensions was the one used (with $\varepsilon = 23;35°$), and G. J. Toomer showed that the latter table (found as no. 17 in his grouping of the Toledan tables) would have given the required value (Taurus 2;12°) for the beginning of the second house in the special case considered, while al-Khwārizmī's would have given Taurus 2;16°. Since al-Battānī found the obliquity by observation – even though many other determinations in the neighbourhood of 23;33° had been made in the decades before – one might take this as proof that the table of houses was added to the Khwārizmī group after his death.[58]

But by whom? Toomer calculated a latitude from each of nine entries, still using the al-Battānī T_1, and decided in favour of around 38;43°, which suggested al-Majrīṭī's figure of 38;30° for Córdoba, and hence a Toledan borrowing from his redaction of al-Khwārizmī.[59]

In offering a slightly different approach, I am aware that it might be in some ways inferior, for it is always safer to use a table that is *known* to have been used than an 'ideal' mathematical function. But here we do not know which table of type T_2 (or equivalent) was indeed used. As it happens, now that we are reasonably certain as to the use of al-Battānī's table of type T_1, we can convert any of the longitudes in the table of houses into right ascensions; and since $\alpha_4 = 90° + \alpha_0$, this allows us to reconstruct entirely a probable table $T_2\ (\lambda_1, \alpha_0)$, or $T_3\ (\lambda, D/2)$, or $T_4\ (\lambda_1, \alpha_1 - \alpha_0)$, or other equivalent. But still we should not be able to disentangle the terms in ε and ϕ in an analysis of it.

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[58] In the mid-ninth century, at about the time of al-Battānī's birth. Note how tenuous is the link between the original work and our only extant version, which is the Latin translation by Adelard of Bath (early 12th century) of a revision by al-Majrīṭī (died c.1007) or even of a second revision by another Iberian, his pupil aṣ-Ṣaffār.

[59] See n. 58.

This last problem may be explained with reference to two worked examples, both from the Toledan tables, where the second table of houses occurs in some manuscripts, also said to be from Toledo. I select eight pairs of values from each table, for λ_1 and λ_4, as follows:

(A) 'al-Khwārizmī'[60]		(B) Toledan? (MS Laud)[61]	
λ_1	λ_4	λ_1	λ_4
30°00′	107°02′	30°00′	106°40′
45	116 45	45	116 14
60	(127 50)	60	127 24
75	141 42	75	140 52
105	176 24	105	175 27
120	196 32	120	195 29
135	216 08	135	(216 08)
150	235 06	150	(235 06)

The bracketed entries are discarded, in (A) because idiosyncratic, in (B) because the scribe has mixed in material from perhaps two other tables,[62] and the entries here are taken, with others in Leo, from the first table. One further set of data: for $\lambda_1 = 0$, we find

$$\lambda_2 = 32;16°, \qquad \lambda_3 = 62;10°, \qquad \lambda_4 = 90°,$$
$$\lambda_5 = 117;50°, \qquad \lambda_6 = (147;48°).$$

(The last entry is from yet another stray column.) Remembering that, in this special case, $\alpha_2 = 30°$ and $\alpha_3 = 60°$, we apply equation (2) and derive successively $\varepsilon = 23;52,17°$ and $23;51,57°$. This suggests al-Khwārizmī's version of T'_1.[63]

The next step is to compute values of α_1 and α_4 *using the appropriate value of* ε (23;35° and 23;51° respectively), with equation (2) and thereafter calculate the product

$$(15)\quad \tan\varepsilon \tan\phi = \frac{\cos(\alpha_1 - \alpha_4)}{\sin\alpha_1},$$

where ε must be taken as potentially different from that first used. (The equation is obtained from (5), with the rule that $\alpha_4 = 90° + \alpha_0$.) The results of doing so are, taking the arithmetic means of the seven (for A) and six (for B) values obtained:

$$\tan\varepsilon \tan\phi = 0.349090316 \qquad \text{(A)}$$
$$= 0.363073094 \qquad \text{(B)}$$

In the next stage we assume that the value of ε implicit in (15) is one of the five on the following list:[64]

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[60] From Suter's tables 79–90.

[61] From MS Laud misc. 644, ff. 42r–44v.

[62] See Toomer (1968), p. 146.

[63] See under heading (d), p. 18 above.

[64] On the possibility that more than one value is implicit in this second phase, see p. 25 above.

$$\varepsilon = \left.\begin{array}{l} 23;30^\circ \\ 23;33^\circ \\ 23;33,30^\circ \\ 23;35^\circ \\ 23;51^\circ \end{array}\right\} \begin{array}{l} \text{implying} \\ \text{respectively} \\ \text{that } \phi = \end{array} \left\{\begin{array}{lll} \text{(A)} & & \text{(B)} \\ 38;46^\circ & \text{and} & 39;52^\circ \\ 38;42^\circ & & 39;48^\circ \\ 38;41^\circ & & 39;47^\circ \\ 38;39^\circ & & 39;45^\circ \\ 38;18^\circ & & 39;24^\circ \end{array}\right.$$

There is an element of the precarious in these results, as may be seen from the fact that had no value from the (A) list been rejected, the values for ϕ would have been around 4′ to 6′ lower. The final step, that of selecting a probable latitude, and hence a preferred value of ε, might under certain circumstances be judged a reasonable one to take. Here we know that the latitude accepted for Toledo in the canons to the tables is 39;54°, suggesting that (B) belongs to Toledo, and that it is based on a table T_2 (or equivalent) that does *not* incorporate the Ptolemaic obliquity, as the accepted T_1 had done. (One would presumably choose the middle value of ε by reason of the availability of the Toledan T_2 and T_3 incorporating this parameter.)

As for the city for which (A) was intended, there is a strong likelihood that Toomer's suggestion (Córdoba) was right, and that the lost al-Khwārizmī table T_2, with (presumably) its Ptolemaic obliquity, was used, since al-Majrīṭī had $\phi = 38;30^\circ$.[65] The method outlined here, be it noted, is a very simple one, and if we are to use only small numbers of tabulated values, is preferable to a sampling of longitudes for the other houses. The reason is that they involve divisions of the two major arcs (into three parts each), with consequent loss of accuracy (through rounding) that cannot be restored.

Finally, recalling that the section of the 'Toledan' table (from which came (B)) lying between the sixth house for ascendents in Leo and the entire Capricorn table, inclusive, is for a different latitude, I will give here the results of a calculation similar to that given above for (A) and (B). By the Libra 0° test we find that the Ptolemaic obliquity was used. Very many of the names of the signs are miscopied, but correcting them I find from a sample of ten readings a longitude $\phi = 41;11^\circ$ (to the nearest minute, with a standard deviation of 2′26″). The Capricorn table indicates a longitude a few minutes lower, and is here excluded. There is a slender chance that these sections of the table of houses in MS Laud misc. 644 have a connection with Abraham ibn Ezra, as I shall explain later.[66]

1.7. *Horoscopes as a guide to geographical latitude. The problem of error through the use of rounded data.*

This is a suitable point at which to outline a first approach to the analysis of a horoscope divided in the Standard manner. (In certain other traditions the method still applies, as we shall see.) We need only select λ_1 and λ_4 (or λ_{10}) to apply equations (2) and (15), whether with a single value for ε, or a succession of values, to give one or more values for ϕ. Even an approximate value for ϕ might lead one to the tables(s) likely to have been used to cast the horoscope. I shall give examples at a later stage. For the present, however, it is necessary to add an important word of warning. We are not dealing with a mathematically precise situation. We cannot easily control the mistakes made in a horoscope, except in relatively trivial cases (such as the failure to make opposite cusps differ by 180°, or a blatant slip in

[65] Abū Maʿshar came from Balkh and wrote a lost work on rising times, whilst al-Khwārizmī gave 38;40° as the latitude of the place. Perhaps this is a coincidence. See Mžik (1926), p. 27, on the latitude.

[66] Section II.9.

writing down the cusps), nor can we be certain of the way in which the astronomer was wont to round (up or down) his cusp longitudes, let alone the steps in his calculation. The question of the former sort of rounding is at least open to examination – with some surprising and chastening results.

The two equations on which a derived latitude are based are, as just explained,

$$\tan \alpha = \cos \varepsilon \tan \lambda, \text{ and } \tan \varepsilon \tan \phi = \sin \frac{(\alpha_1 - \alpha_{10} - 90^\circ)}{\sin \alpha_1}$$

The first of these equations is to be applied successively to λ_1 and λ_{10} to give the corresponding right ascensions for use in the second. The worst errors will be where the cusps are quoted only to the nearest degree. We may assume that nothing worse will be encountered, but rounding to degrees is common. I know of no systematic study of habits of rounding. One does rarely come across astronomers who round systematically up; others who round upwards only when it would seem foolish to round down (as with, say, 33;58°); but the great majority of astronomers seem to have rounded *systematically down.* We must often assume the worst, and take it that λ_1 and λ_{10} might be as much as a degree above *or* below their quoted values. Often only one of the two will be subject to uncertainty.

It is a straightforward but very cumbersome matter, not highly appreciated by printers, to develop an analytical expression for the resultant range of error in the latitude. I will confine myself to a few general remarks, before using a different approach. The error in ϕ can, as it turns out, be written in the form

$$(A\, \delta\lambda_{10} - B\, \delta\lambda_1)\cos^2\phi,$$

where A is a rather complicated function of λ_1 and λ_{10}, but where B is (apart from a term in the obliquity) $\operatorname{cosec}^2\lambda_1$. We may therefore make some rough generalizations: the method works *best in high latitudes* (when the cosine is least). It is *dangerous when λ_1 is close to 0° or 180°*, for then B may be very great. The form of the function A is such that we may say, roughly speaking, that the method is *dangerous when λ_{10} is close to 90° or 270°*. So much for generalities.

Whenever there is any doubt as to the acceptability of a derived value for ϕ, it is a simple matter to perform the basic calculation of ϕ four or five times over, that is, not only for the listed values of λ_1 and λ_{10}, but also for each value increased and decreased by a degree. I will give a suitably alarming example, taken from the first section of Part II, below. The horoscope there taken from the work of Neugebauer and Van Hoesen, no. L 621, has $\lambda_1 = 200^\circ$ and $\lambda_{10} = 112^\circ$, and for textual reasons this was supposed to be for clima V (ϕ = 40;56°). Applying our method, with the Ptolemaic obliquity of 23;51° (which is most certainly not critical!), we find the following values for the four corners of what we might call our 'square of error'. (The figures are in decimals of a degree.)

λ_1 200°	λ_{10} 112°	ϕ 34.08°
201	113	33.44
201	111	22.18
199	113	44.18
199	111	34.76

Mean of the four: 33.64.

Range of uncertainty:
22.18° to 44.18°
(With the assumption of
rounding down only, this
range would have been
28.12° to 38.96°.)

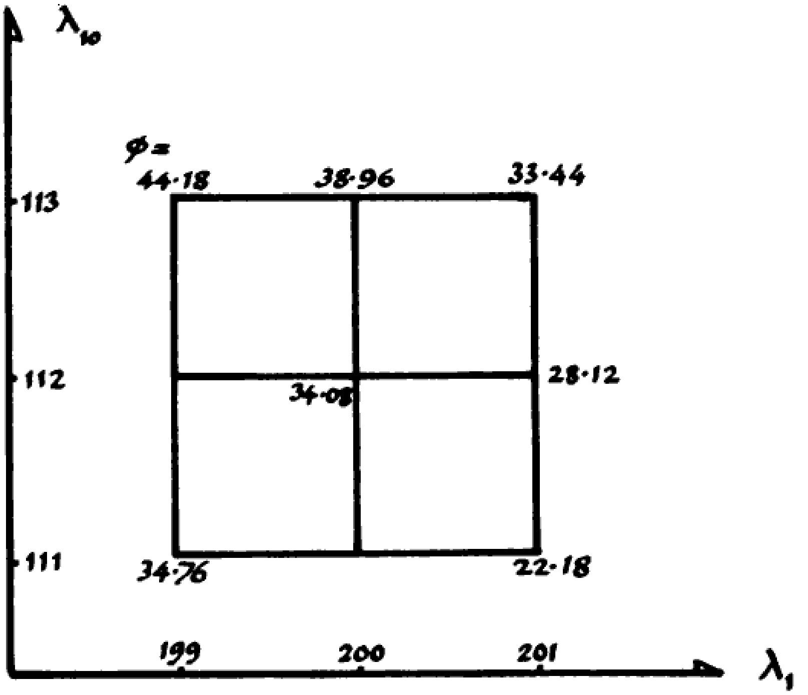

Fig. 4 The 'square of error' in the latitudes derived from a particular pair of values for the ascendent longitude (200°) and that of mid-heaven (112°).

It is easy to locate worse examples than this, but we can at least see the problem clearly enough. And we note that within the terms of that problem it is quite easy to accommodate the hypothesis that this horoscope was calculated for the fifth clima. There will be authors whom we know to have kept to some stringent rule – for instance, rounding down only. There is no new principle, and for all practical purposes it is easier to perform five calculations, as above, than to work from a convoluted analytical expression.

When the cusps are quoted to minutes of arc, the range of uncertainty will be much smaller, but it need not be inisignificant. An astrologer might show, moreover, by the fact that all cusp longitudes are quoted to fives or to tens of minutes that he was rounding in the corresponding way. Rounding to five minutes was probably done in the horoscope of Gradi, discussed in another connection in section I.18, where the houses however are given only to the nearest degree, apart from the cardinal angles ($\lambda_{10} = 2;05°$, $\lambda_1 = 112;35°$). Taking $\varepsilon = 23;30°$, the four vertices of our square of uncertainty give values for ϕ of 43;47°, 44;02°, 44;13°, and 43;58°, covering a range (43;47° to 44;13°) that cannot accommodate the latitude of birth (43;30°).

A word of optimism is in order here. It is almost always possible to say, when a horoscope has data in degrees only, that the figure quoted either for λ_1 *or* for λ_{10} is the *precise* figure used in the calculation, and that only the other is rounded. If the figures quoted are respectively a and b, and if we write $\phi(a,b)$ to mean the derived value of the latitude and if, furthermore, we are fairly sure that rounding is always done to the nearest degree, then the range of uncertainty is *either* $\phi(a - 30',b)$ to $\phi(a + 30',b)$ *or* $\phi(a,b - 30')$ to $\phi(a, b + 30')$. Thinking in graphical terms, one might choose to talk of a 'cross' of uncertainty. (See Appendix 4 for an illustration.) It is unfortunately impossible to generalize about the question of whether λ_1 or λ_{10} is taken as the starting point of the calculation. Both possibilities exist.

Two final caveats: In Part II there are numerous applications of the formulae of this section, leading to values for the latitude that are quoted to minutes or even seconds. This is never to be taken to imply that the figure accurately represents the latitude assumed by the astronomer in his calculation. It is a purely analytical consequence of the data given in the horoscope (or whenever), when there is evidence that the cardinal angles are capable of indicating a latitude (with certain types of horoscope they are not.)

Finally, it has to be emphasized that this section applies to the Standard method of casting the houses, and also to certain other methods that take into account the four cardinal angles (ascendent, mid-heaven, and their nadirs), in the way the Standard method does. With the notation of I.17 below, these others are methods (0), (2), (3), and (4). The most important exceptions are methods (5) and (6), there called the Equatorial (moving boundaries) method and the Single Longitude method, respectively. It is as well to be aware of what happens when one applies the method for latitude indiscriminately. With (5), a latitude of zero should invariably be obtained. With (6), we may show that the *derived* (but strictly meaningless) latitude ϕ' is related to the obliquity by the equation

$$\tan \phi' = \tan \varepsilon \sin \alpha_{10}.$$

Since $\sin \alpha_{10}$ lies between 0 and 1, this means that ϕ' will always be found to lie between 0° and ε. That one has obtained a latitude in this improbably low range should be enough to alert one to a possible mistake in procedure. The computer programme of Appendix 4 allows an immediate assessment to be made of the ranges of uncertainty of the second type (the 'cross' of uncertainty).

I.8. *New methods and old confusions. The method of Abraham ibn Ezra using unequal hour lines. Magini's algorithm*

The history of mathematical methods for casting the houses has long been presented as a much more complex subject than I have so far made it out to be. At the heart of the modern confusions come Gazulus and Regiomontanus and their desire to simplify standard procedures. Others of the period, encouraged to try their hand at revision, succeeded only in introducing yet more convoluted principles, not to mention a standard historical account that has been repeated uncritically again and again. It is now almost *de rigueur* to refer one's account back to C. A. Nallino's commentary on his edition and translation into Latin of al-Battānī's astronomy,[67] but Nallino relied to a large extent on a work published by V. Nabod in 1560: *Enarratio elementorum astrologiae, in qua praeter Alcabicii, qui Arabum doctrinam in compendio prodidit, expositionem atque cum Ptolemaei, de verae artis praeceptorum origine et usu satis disseritur* (Cologne). As Nallino says, this is a long work but lacking in mathematical proofs. Nallino criticizes J. B. Delambre for some misunderstandings (of al-Battānī and al-Qabīṣī), in the second case, at least, I think wrongly; but his guide to the historiography of the whole subject is useful. Delambre's account[68] is interesting for other reasons. He was concerned to present the alternative methods in mathematical detail, and obviously had much greater trouble deriving the Standard method (as we are calling it) from his main source, Giovanni Antonio Magini,[69] than in explaining a method of division attributed to Ptolemy. (Admittedly, he acknowledged the Standard method to be of such simplicity that he thought it must be the oldest!) Magini, with his own voluminous tables, was one of those who in the sixteenth and seventeenth centuries helped to promote new methods and at the same time to obfuscate history. He thought that Regiomontanus's method was derived from Abraham ibn Ezra's, and that it came close to Ptolemy's. The first of these theses is one we shall have occasion to discuss in this section – it is mistaken, but is repeated blindly by many modern writers. And if there is a method attributable to Ptolemy on the basis of *Tetrabiblos,* there is no good reason for thinking it to be that described by Magini. The method in question, as Delambre said, was bizarre. It is not, however, as bizarre as it seems when described in the (analytically correct) way chosen by Delambre. The cusps of the houses, as he quite correctly said, are in this system decided by the unequal hours, but each by the unequal hour corresponding to the cusp's *declination.*[70] Rather than explain this rather opaque description, I shall introduce the method in a more graphic way. First, however, I shall make a number of very brief observations, with the aim of introducing a little light into a jungle of attributions. I make no claim to having found the true author of the method in question.

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[67] Al-Battānī (Nallino ed., 1903 etc.), vol. ii, pp. 246–9 (ad cap. xxxv).

[68] Delambre (1819), esp. pp. 288–91, 495–506.

[69] Magini (1604). For full bibliographical descriptions of Magini's works, see the 'Bibliografia maginiana' in Favaro (1886), this being item 17. Mr Angus Clarke tells me that the 'licentia Superiorum' was granted 6 November 1603.

Perhaps the two most commonly used methods for casting the houses accepted by modern astrologers – most of whom have not the slightest inkling of what they are using – are those of Regiomontanus (which seems to have been promoted especially from Germany) and (as the pundits would have it) of 'Placidus'. There is an awareness that the latter method was used in the very common tables of Raphael; and that serious doubt was cast on its acceptability when astrologers were required to cast a horoscope for Mary Peary, the daughter of the Antarctic explorer. (She was born within the Arctic circle, at a latitude (77;44°) at which the method could not be applied!) 'Placidus' is Placido Titi (1590–1668), a Perugian monk of the Olivet congregation, whose system was fashionable throughout Europe in the late seventeenth century and after. It was introduced into England by such astrologers as John Partridge (who learned it from his tutor Francis Wright), Richard Kirby and John Whalley.[71] Some writers are aware that the system 'really' comes from Magini. Magini, as already observed, thought he had found the system intended by Ptolemy. That he was not the first with this idea will be seen in section I.22 below, when we come to consider an astrolabe of 1304/5 A.D. which seems to imply that its maker had the same view of Ptolemy's intentions.

Before we turn to an earlier description of it – a description that is hardly less obscure than Delambre's – the system that will later be given the title 'Hour Lines (fixed boundaries) method' will first be simply and briefly described, without any prejudice as to the historical problem of its origins. Although astrolabe methods for the houses have not yet been systematically described, some readers will see at once from its name what is implied. In the systems of 'Regiomontanus' and 'Campanus' it is possible to draw a set of fixed lines on an astrolabe plate for a particular latitude, and where the ecliptic is intersected by these lines, there are the cusps of the houses. With the Hour Lines method, *the fixed lines are simply the standard (unequal) hour lines.* From the point of view of astrolabe work, this system is truly simple. From an analytical point of view it is undoubtedly the most difficult of all the systems to be considered in this work.

The Hour Lines method may of course be described without any reference to astrolabe technique. In the course of the daily rotation, an arbitrary point of the ecliptic (except for the special cases of the equinoctial points) describes two unequal arcs of a small circle (in the geometer's sense, that is, not a great circle, so called), one above and one below the horizon. Suppose each of these to be divided into six equal parts. The points of division will describe certain curves on the celestial sphere, as the point on the ecliptic varies (the broken lines in Fig. 5), these curves lying between the tropics. For any arbitrary positioning of the ecliptic circle, i.e. corresponding to the time for which the horoscope is cast, the ecliptic will be cut by these curves (one of which is the meridian) and the horizon at the twelve points that are to be counted as the cusps of the houses. Each cusp corresponds, as Delambre had it, to the unequal hour division corresponding to the cusp's declination.

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[70] Delambre (1819), p. 503, provides an analysis of the supposed Ptolemaic procedure, for which Magini supplied an algorithm. See below.

[71] Capp (1979), p. 183.

Some exact equations will help to show the analytical difficulties encountered by those who sought to use the method in this way. The right ascensions of the twelve cusps will be denoted, as always, by $\alpha_1 \ldots \alpha_{12}$, and now their declinations will be introduced, namely as

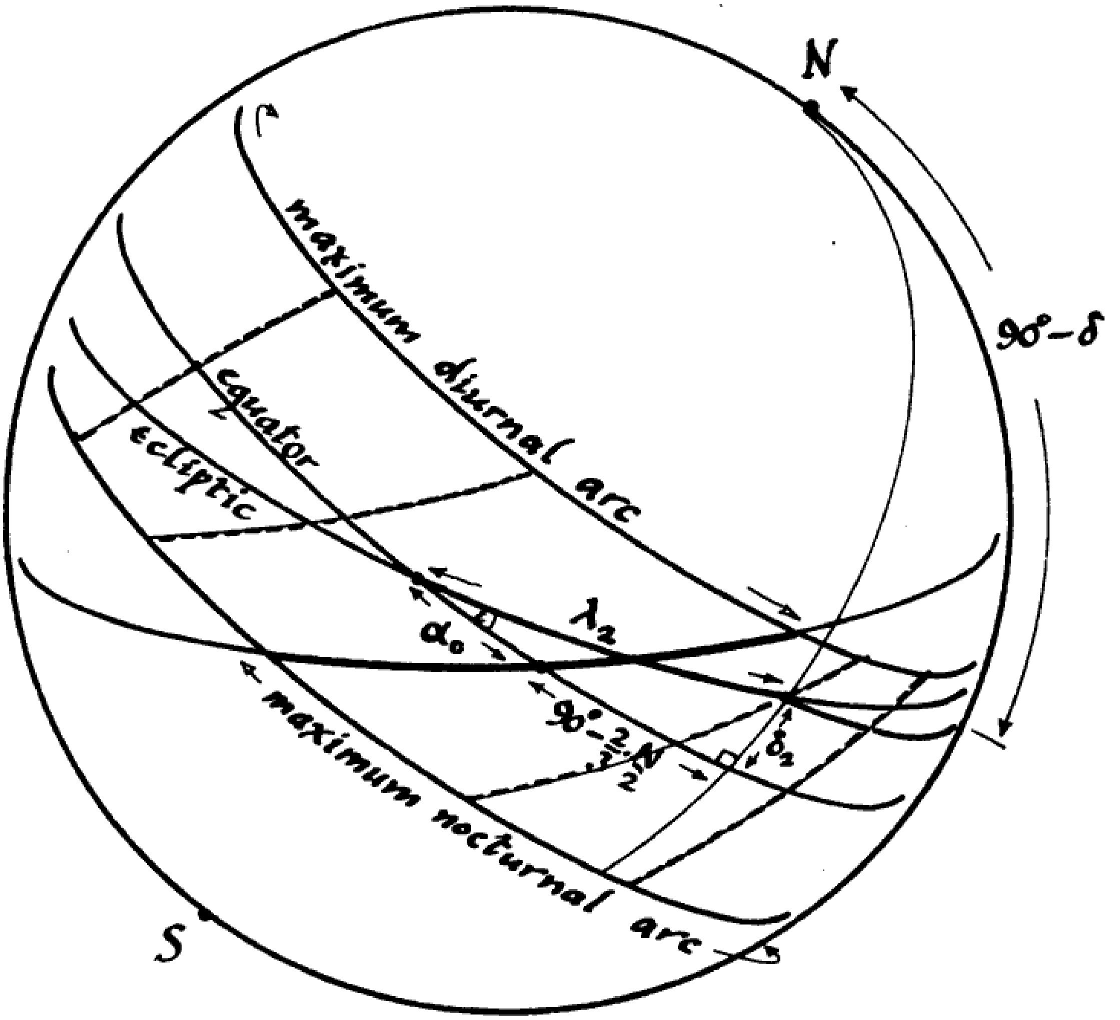

Fig. 5 The Hour Lines (fixed boundaries) method. The construction for the beginning of the second house is shown. The broken lines are (alternate) lines of unequal hours, that is, they are the loci of points marking equal divisions of the diurnal arc of the Sun. Here the diurnal arc is divided into six, and the nocturnal likewise (not all shown). The cusps of the houses are where the ecliptic cuts those lines, which are fixed for a particular latitude.

$\delta_1 \ldots \delta_{12}$. The diurnal arc described by an arbitrary point of the ecliptic will be D in extent (as before), and the corresponding night arc will be denoted by N. The four cardinal angles will be found as before, lying as they do on the horizon and meridian circle. For any cusp declination, equation (4) holds good:

$$(4) \quad \tan\delta = \sin\alpha \tan\varepsilon,$$

and as before,

$$(13) \quad \tan\phi \tan\delta = -\cos\frac{D}{2} = \cos\frac{N}{2}.$$

By the definition of the cusps given above:

$$(16)\ \alpha_{11} = \alpha_{10} + \frac{1}{3}\cdot\frac{D_{11}}{2},\ \alpha_2 = \alpha_4 - \frac{2}{3}\cdot\frac{N_2}{2},$$

$$\alpha_{12} = \alpha_{10} + \frac{2}{3}\cdot\frac{D_{12}}{2},\ \alpha_3 = \alpha_4 - \frac{1}{3}\cdot\frac{N_3}{2}.$$

Clearly α_{11} is a solution to the equation in α:

$$(17) \quad -\cos 3(\alpha - \alpha_{10}) = K \sin\alpha,$$

where $K = \tan\varepsilon \tan\phi$. It is easily verified that α_3 is another solution to the same equation, while α_{12} and α_2 are solutions to the equation in α:

$$(18) \quad -\cos 2\,(\alpha - \alpha_{10}) = K \sin\alpha.$$

The remaining cusps are found by symmetry.

Equations (17) and (18) admit of exact solutions, but they are very cumbersome for ordinary use, involving as they do cubic equations in $\tan\alpha$. There is no point in my writing these solutions out in full.

An iteration method may be used along the following lines: assume, as a first approximation, that $\alpha_{11} = \alpha_{10} + 30°$. Substitution in (4) gives a value for δ_{11}, which when substituted in (13) provides a value for D_{11}. This, used in (16), gives a value for α_{11} different from that initially assumed, and closer to the correct value. This new approximation is then used with the same procedure, and the process is repeated until the required accuracy, as indicated by the separation of two successive solutions, has been reached. A similar process may be used for the other cusps, taking initial approximations at intervals of 30° in an obvious way.

I now turn to the historical problem of the origins of this fixed boundaries method, which seems to me to have obviously stemmed from astrolabe techniques. On the face of it, the method seems to be that intended by Abraham ibn Ezra in his *Séfer ha-moledot (Liber nativitatum)* composed at Béziers in its two versions in 1148 and 1154, as well as in the *Keli ha-neḥoshet (Tractatus de astrolabio)*, evidently translated in England between 1158 and 1161, and also that in his book on the foundations of astronomical tables.[72] This last work, the Latin version of which has been edited by Millás, refers back to the astrolabe treatise, where he 'showed how to distinguish the houses easily'.[73] In retracing the steps in the earlier explanation, Abraham leaves us in little doubt as to his intentions, for now he adds a sketch of the theoretical underpinning, as well as an explicit criticism of the Standard method of domification, which he ascribes to al-Khwārizmī and Ibn al-Muthannā. It is worth noting here that the surviving (Latin) tables of al-Khwārizmī incorporate modifications by al-Majrīṭī; that Ibn al-Muthannā's commentary on the tables, dating from the tenth century, takes us nearer to their author; but that Ibn al-Muthannā's work, surviving only in Hebrew and Latin, does admittedly have between it and the Khwārizmī zīj the influential-ninth century criticism of al-Khwārizmī by al-Farghānī. We may be reasonably sure that this last qualification does not affect the truth of the statement that al-Khwārizmī subscribed to the standard method.[74]

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[72] See Millás (1949), ch. xi, for a general study.

[73] See Millás (1947) for text and commentary, pp. 159–61 for the passage under discussion, and pp. 15 and 56 for references to parallel texts.

Abraham's criticism was inspired by the thought that the older method would give different results from his own in the calculation of aphetic points (*alileg*). This criticism need not detain us. Abraham's treatment of the cardinal points of the horoscope is perfectly standard – they are the ascendent, mid-heaven, and their opposites. As he explains, the interval in right ascension from mid-heaven to the ascendent is the equivalent of six unequal hours (*hore temporales*). When he comes to the interval between the cusps of the tenth and eleventh houses, however, this will be two hours (unequal) of a size corresponding to the degree of the beginning of the eleventh house:[75]

> Secundum hoc differentia que est a principio 10^{me} domus ad principium 11^{me} in tabula circuli recti, erit duarum horarum temporalium secundum horas temporales gradus principii 11^{me}, et erit differentia ascensionum inventarum ante principium 11^{me} ad ascensiones orientis in tabule terre, tamquam 4 hore temporales secundum gradum principium 11^{me}.

I take it that this is a description of the method described in this section as the Hour Lines (fixed boundaries) method.

This text by Abraham ibn Ezra poses a number of problems. The first, as to the source of inspiration, he does not allow us to solve from his own writings. Despite his appeal to Ptolemy, Dorotheus, Māshā'allāh, Abū Ma'shar, and 'omnes saraceni quoque magistri probationum', on the doctrine of *alileg*, for all his text tells us the method of house division here offered might have come out of the blue. More puzzling by far, however, is the way in which he ends the chapter in question. 'Nos vero in *Astrolabio* docuimus facile distinguere domus', he wrote, following on with what, at a glance, reads like the fixed rete technique for the Standard method of house division (described in section I.18 below). Although I have not consulted his (Hebrew) treatise on the astrolabe, I have referred to a minuscule tract he incorporated in his canons to the Pisan tables (c.1154), where he seems to be advocating the Standard method with what I shall later call the moving rete way of finding the houses.[76] In neither case is his explanation particularly clear, but we should at least try to square the later instructions for the use of the astrolabe (that is, those in what Millás called 'El libro de los fundamentos de las Tablas astronomicás') with the Hour Lines (fixed boundaries) procedure.

In this continuation of the chapter which certainly *began* with that method, we are told to use our astrolabe to see how many equal degrees there are from mid-heaven to the east (*ad orientem*), and to divide them by three.[77] Now there are always 90 degrees to the east proper, so Abraham presumably meant that we should work to the ascendent point, on the eastern part of the horizon. He goes on:

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[74] For an English translation of a relevant passage, see Goldstein (1967), p. 85.

[75] Millás (1947), p. 160.

[76] This occurs at ff. 65va,b. This tiny tract on the astrolabe included a number of chapters illustrating and illuminating his other canons. At the end of the Pisan chapter he wrote 'Hec est domorum distinctio secundum antiquos Ptolomeum et Doronium [his standard spelling of the name of Dorotheus of Sidon]'.

[77] See n. 75.

> Et nota arcum hore temporalis gradus illius signi ubi terminatur particio; illum arcum duplica. Deinde vide differentiam ascensionum gradus medii celi ad ascensiones illius gradus; si illa equatur duplicato, ille gradus est principium 11^{me}.

One might suppose here that Abraham was dividing the right ascensional arc in the usual way according to the Standard method, to provide him with a *provisional* value for λ_{11}, before using this to determine the arc corresponding to two unequal hours for that particular ecliptic longitude of the Sun. The beginning of the eleventh house is – it seems – supposed to begin at this angular distance from mid-heaven. To read his instructions in this way is to provide an analogue to calculation by iteration. It certainly reinforces the feeling given by the first part of his chapter, that he had not appreciated the essential simplicity of the method, in relation to the astrolabe. I suggest, then, that someone before Abraham invented the method in pondering the use of an astrolabe – perhaps even before the other fixed-boundary methods. I suggest that the method was then given a more abstract description (cf. Magini and Delambre), and that Abraham was following this more abstract account. I find it hard to believe that one who presented the method as did he, could have been its inventor, but it has to be admitted that while we know of earlier uses of the other fixed boundary methods, we at present know of no earlier use of Abraham's method, so the sketch offered here of its probable origins might prove in the future to be untenable. The astrolabe of 1304/5 that associates the method with Ptolemy's name will later be seen to have originated in Granada. It is surprising, in fact, in view of the occurrence of the other fixed boundary methods in the Alfonsine books (c.1270, but mostly translated from earlier writings) that these contain, so far as I can see, no allusion to Abraham's method.* In those works, 'Ptolemy's' is the Standard method.

So much for the early history of Abraham's method. Its transmission to the sixteenth and seventeenth centuries in association with his name came about through the translation of the *Liber nativitatum* made by Peter of Abano, plentiful in extant manuscripts, and printed at Venice in 1485. There was a new translation, but never printed, done by Ludovicus de Angulo in 1448.[78] In section II.9 we shall examine the horoscopes in the printed edition, which are all done for a latitude in the neighbourhood of 49° and by the *Standard* method. It will be shown that they relate to the printing history of the book, or at least to the time of printing. They do not reflect on Abraham's practice. It is hard to see where the idea came from, that Abraham was the first to devise the procedure favoured by Regiomontanus. Whether he inspired Regiomontanus to produce independently a method that we know to be older than he, is anybody's guess. There is another reading of Ptolemy – Nabod had it, as we shall see (I.15) – that again made it seem that Regiomontanus was following him, in a certain sense. On this reading they were in agreement in that they made each of the houses *correspond* in extent to 30° of right ascension, and likewise took the ascendent as their starting point; but the mode of correspondence was quite different. For Ptolemy, supposedly, the correspondence was established as in the Standard method described earlier, with great circles from the poles leading from the equatorial divisions to the ecliptic. For Regiomontanus the great circles radiated from the north and south of the horizon. I shall shortly explain Regiomontanus' system more fully, together with some of the other alternatives mentioned in passing already.

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[78] Thorndike and Kibre (1963), col. 749, for the first 'Omnis intendens . . .' printed 1485 (Peter was born in 1257), and col. 998 for the second, 'Inquit magister noster Abraham . . .' Abraham ibn 'Ezra wrote much and was much copied, and it would be a labour of love to trace the history of this one small component of his work.

* Note added in proof: Applying the programme of Appendix 4 to three horoscopes drawn up by Levi ben Gerson in a text connected with the great conjunction of 1345, it appears that all are based on the *Hour Lines* method. The text is currently being edited by Professor B. R. Goldstein, whom I have to thank for supplying the horoscopes. They are surprisingly well calculated, and for Levi's own latitude (44°), despite their connection with world history (cf. section I.20 below).

To this end this section, however, a brief account of the computational procedures of Giovanni Antonio Magini (1555–1617) is called for. Magini tends to be viewed rather condescendingly today, largely because he opposed Copernicanism and made an enemy of Galileo. He was nevertheless an extremely versatile practitioner of mathematical astronomy – and it is not hard to see why he was preferred for the chair in mathematics at Bologna over Galileo (1588), Galileo being in any case nearly nine years younger. He was one of the most accurate of calculators, before the age of logarithms – indeed reminiscent of them is his *Tabula tetragonica* (1592), a table of squares of the natural numbers, meant for assistance in long multiplication, the numbers to be multiplied being first expressed as the difference between two squares. There is much to be said on his role in the history of mathematical tables generally, but here we are concerned only with those he drafted for use with the Hour Lines (fixed bounds) method. He seems to have been the first with an acceptable computational algorithm for it. We have already seen how difficult the mathematical problem is, and how an iteration method offers the easiest solution. Magini's solution relied on the inverse use of tables he had calculated.

The method is explained in Magini's *Tabulae primi mobilis,* with the imprint Venice 1604, but is evidently usually associated with a later composite work, his *Primum mobile, duodecim libris contentum* . . ., which was accompanied by a vast set of *Tabulae generales ad primum mobile spectantes* . . . (Bologna, 1609).[79] This very remarkable collection, published in large format at the author's expense, must surely count as the most thorough work of spherical trigonometry of what could be loosely called the pre-algebraic period. As for Magini's method, we may say that – turning back to the explanation offered on p. [21] above – he gave, in effect, tables in which one searched for the known α_{10}, and then for the longitude (the argument of the table) to which it corresponded. This is a gross oversimplification, but let us first explain what he might have done, rather than what he did. Suppose we are looking to find the cusp of the eleventh house. For every longitude a particular value of D_{11} and a particular value of α_{11} correspond (equations (1), (4), and (13)). By equation (16), therefore, a particular value of α_{10} corresponds to that longitude. A table could be drawn up for the entire range of longitudes, allowing the problem to be handled inversely. One would begin, perhaps, from λ_{10} as a datum; find α_{10} by familiar methods; and then search for it in the body of the table, yielding finally λ_{11}.

This is not exactly as Magini proceeded. He took not D but the excess of D over 180°. And the entries in his table omitted the term in right ascension (α_{11} in my example), since another table may be set up in the familiar way, relating it to the longitude. This had the disadvantage that one had to go through an extra stage in the calculation, although that was no great hardship. It had the advantage that only a double (new) table was needed to cover the four cases of equation (16), rather than a fourfold table. All told, his method was ingenious and straightforward to operate, although explained by him in a very peremptory way. There were interpolation problems of a sort reminiscent of some that Regiomontanus's method had encountered. That it was more than a century before the new style of computation began to catch astrologers' imagination is hard to explain, but it has something to do with German pride in 'our Regiomontanus', and perhaps even more to do with difficulties of comprehending Magini's intentions. His great spokesman, as stated earlier, was Placido Titi. As for some insight into Magini's various practices, see Appendix 4. He was evidently not above using the method of Regiomontanus.

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[79] See n. 69 above. The later (dual) work comprises items 27 and 28 in Favaro's bibliography.

1.9. *Regiomontanus's* Tabulae directionum, *Gazulus and Campanus*

A typology of methods for casting the houses will be given later, in section I.17, but first we ought to investigate the history of the other two fixed boundary methods, those ascribed to Regiomontanus and Campanus. This is a very convoluted subject, as a result of a historical orthodoxy settled in the sixteenth century and continuing to our own time. I begin with the great upheaval of the fifteenth century.

The two fixed boundaries methods in question are easily described. Both are reminiscent of Abraham ibn Ezra's. In both cases the ecliptic is divided by a sheaf of six 'horizons' (as they are commonly called – or even, more misleading, 'horizontal circles') through N′ and S′, the north and south points of our[80] horizon. In both cases our meridian and horizon (sometimes distinguished as 'right horizon') comprise two of the six 'horizons'. In the 'method of Campanus', the others make angles of 30° with them at N′ and S′. In other words, the sheaf divides the prime vertical (the great circle through the zenith, Z, and east, E) into 30° segments. (See Fig. 6. In Fig. 2, ϕ takes on values of 0°, 30°, 60° . . . etc.).

In the method of Regiomontanus, it is the equator that is divided equally by the sheaf of horizons (Fig. 7), so that in Fig. 2, El (=h) takes on values of 0°, 30°, 60°, . . . etc.

The advantage in these two systems, from an astrologer's point of view, is that the great circles fixing the cusps of the houses are *fixed*, for an observer at a particular latitude,

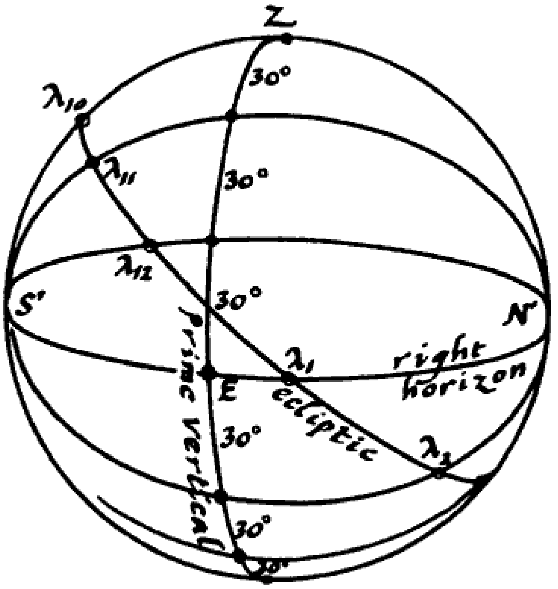

Fig. 6 The division of the ecliptic into houses according to the Prime Vertical (fixed boundaries) method, commonly ascribed to Campanus. The boundaries of the houses are where the fixed great circles through N′ and S′, the north and south points of the horizon proper (*horizon rectus*) cut the ecliptic. These great circles, 'circles of position', or even 'horizons', pass through the 30-degree divisions of the prime vertical in the manner shown. E is the east point of the horizon.

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[80] That is, from the point of view of the subject.

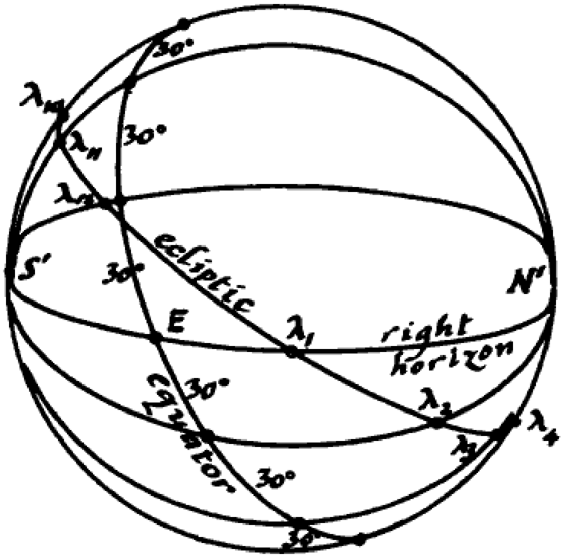

Fig. 7 The division according to the Equatorial (fixed boundaries) method, commonly ascribed to Regiomontanus. The circles of position now pass through the 30-degree divisions of the equator.

and can therefore be inscribed on an astrolabe plate, making for very rapid casting of the houses. This advantage was less commonly exploited than it would have been but for the drafting by Regiomontanus of a fairly comprehensive set of tables, which seem to have swept across the whole of Europe very effectively in the sixteenth century. These were the *Tabulae directionum profectionumque* . . ., computed with the help of Martin Bylica in 1467, first printed in 1490, but circulating in manuscript beforehand, and reprinted in many later editions.[81] The most important change in the contents occurred when Erasmus Reinhold supplemented them with tables of ascensions for geographical latitudes between 61° and 89° inclusive. Before considering their contents, however, and historical questions surrounding the method ascribed to Campanus that so obviously prompted Regiomontanus to produce them, we should examine their mathematical form.

Given the longitude of the ascendent, λ_1, the crucial problem is that of finding successive values of the arc VC (Fig. 2), when θ (Camp.) or h (Reg.) is an integral multiple of 30°. Equation (12) gives λ, the arc VC, as a function of h and α_0, which latter may be found by the standard methods. This solves the Regiomontanus problem. Note that he took the obliquity to be 23;30°.[82] The Campanus-Gazulus solution is one that we may reach by first converting known values of θ (30°, 60°, etc.) to h, by equation (11), and then proceeding as before.[83] The first step is something that needs to be done once only, for a particular latitude.

It is to be stressed that the procedures explained here are as seen from a modern perspective, not limited by the traditional styles of table and function. In the following section we shall see how *traditional* techniques were harnessed for their solution. Without this additional information, such tables as Regiomontanus's would be rather difficult to follow.

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[81] The MS presented by Bylica to the Jagellonian Library in Cracow is still there. See the index entry under Martinus Bylica de Elkush (Marcin Bylica z Olkusza) in Rosińska (1984), especially item 930.

[82] Delambre (1819), p. 498, says 23;35°.

[83] Delambre's account is not very different from this, but speaking generally, he makes the computation look easier because he takes mid-heaven as his datum. Also confusing is his reference to the tenth house as independent of latitude: it is so if one thinks of α_0 as a datum, but for given λ_1 this depends on the latitude.

When analysing a horoscope that was evidently cast by one of these two methods,[84] we are in an essentially different situation from that in which use of the Standard method places us. A first analysis using modern trigonometrical tables can tell us most of what we need to know, but now we have the advantage that (astrolabes apart) we can be reasonably certain as to which tables were in use, at least before the late sixteenth century. Needless to say, they contain errors, and these might be expected to show up in the horoscope.

The contents of the *Tabulae directionum*, in brief, include: worked examples on all three systems;[85] tables of declinations, one for points up to 8° north and south of the ecliptic;[86] a table of tangents;[87] one of mediations;[88] tables of ascensional differences, right ascensions, and oblique ascensions;[89] a table 'according to Campanus and Gazulus';[90] and tables for Regiomontanus's own system.[91] These will be explained in the following section. Most of the tables for angles were given to degrees and minutes.

This work of Regiomontanus that was to prove so influential was to some degree directed against the method ascribed to Campanus, the thirteenth-century astronomer of Novara, and the little known Gin Gazul (Johannes Gazulus). Gazul was a scholar of Albanian origin, educated partly in Padua, where he took the doctorate in letters in 1430. He had earlier entered the Dominican order in Dubrovnik, and died there in 1465.[92] Rather surprisingly, no-one, as far as I know, has previously reported finding any work by Campanus that sets down the method ascribed to him. The editors of the once popular equatorium text by Campanus, namely F. S. Benjamin Jr. and G. J. Toomer, mention a work reported in the eighteenth century that was perhaps either the chapter 'De duodecim domibus que sunt in celo' from Campanus' *De sphera*, or an adaptation of it, possibly by Gazul.[93] Nothing was said about the contents of the relevant chapter,[94] but it does in fact turn out, on inspection, to contain a sketch of the 'Campanus' method of dividing the houses. It describes, in other words, the arrangement of the circles in Fig. 6; but there is not the slightest hint of any mathematical algorithm by which the method might be used in practice.

Although there is some reason, therefore, for the tradition of associating Campanus's name with domification by means of a symmetrical division of the local sky, he certainly did not invent it, as will be shown later.[95] What matters for the moment is that neither was he personally responsible for any significant change in European astrological practice.

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[84] See section I.17 below.

[85] Following the edition of 1581 (Matth. Welack, Wittenberg), the only one available to me in Groningen, there are 31 different problems explained, nos. 14 and 15 on the traditional system and no. 16 on that of Campanus and Gazulus.

[86] Ibid., f. 24v–30v; at 30v there is a 'tabula declinationum generalis', namely for points on the ecliptic only.

[87] 'Tabula foecunda', ibid., 31r (for integer degrees, to a gnomon of 100000; not very accurate in the higher values).

[88] Ibid., ff. 31v–53v (for 8 degrees north and south of the ecliptic, with the 'tabula generalis' at 53v).

[89] ibid., ff. 45v–49r ($\alpha - \alpha_0$ for ϕ from 1° by 1° intervals to 60°); ff. 49v–50r (α); ff. 50v–110r (α_0 for $\phi = 1°$ by 1° intervals to 60°), supplemented at the end by Rheinhold's (α_0 for 61° by 1° intervals to 89°; much blank space, where the ecliptic is below the horizon!).

[90] Ibid., f. 110v, these to be used with the tables of position.

[91] Ibid., ff. 111r, with 'Tabulae positionum' at ff. 111v–139r.

[92] The most complete statement of what is known about Gazul will be found in Grmek and Dadić (1976). Nothing by Gazul appeared in print in his day, but he is thought to have been the author of the astrolabe treatise now published by these two modern writers; and he certainly wrote the *De directionibus* discussed below.

[93] Campanus (Benjamin and Toomer, edd, 1971), pp. 19 ff. The *De sphera* was printed in 1518 (twice), 1531, and 1557.

[94] Chapter 29, ff. 155vb–56ra in the Venice, 1518, edition.

[95] Section I.11.

When a minor revolution took place, long after his death, it happened simply because Regiomontanus reacted against Gazul's advocacy of his system. Gazul's work does not survive in any complete version, but there are traces of it in several manuscripts. There is an early table of houses 'secundum Campanum et Gasulum' associated with the year 1468 and the city of Cracow,[96] although this is not in itself very significant or surprising, since Regiomontanus's *Tabulae directionum* were ready, as we have seen,[97] in 1467, and Bylica gave a copy of them to the University of Cracow. As M. Grmek and Z. Dadić show, Gazul's work was sufficiently well appreciated by the king Matthias I Corvin and his humanist circle for them to have issued the Dalmatian scholar with an invitation to visit the court. He declined, but sent to Hungary a copy of his astrological work. This is almost certainly how Regiomontanus came to know it, when in 1467 he visited and worked with Bylica, the astronomer royal in Hungary. (Regiomontanus was there for about four years.)

This is perhaps a suitable point at which to lay to rest an eastern ghost. In his study *Horoskop und Himmelshäuser*, Walter Koch, after speculating idly on places where Abraham ibn Ezra's 'rational method' will be found – that is to say, the method of Regiomontanus – turns to 'der arabische Astrolog Muhammed ben-el Ghazuli, lat. Gazulus (1385–1432)', who followed the method of Campanus and so popularized it that it was used for the crowning of a poet laureate (Celtis) in a work printed in 1499.[98] (In fact the horoscope was calculated according to the *standard* method.) Not the least element of originality in the story is the implication that the method was transmitted from West to East.

I.10. *The adaptation of traditional tables to the new methods, and a resulting weakness*

The geometrical, or – as we should now regard it – trigonometrical analysis of the traditional problems of rising times, division of the ecliptic into cardinal arcs, and so forth, was so well known to the astronomers of the fifteenth and sixteenth centuries that it is not surprising to find them adapting that analysis to their 'new' methods for casting the houses. How they did so may be easily explained with the help of our basic figure (Fig. 2) and formulae of section I.2 above.

A table of oblique ascensions for latitude ϕ essentially encapsulates the relation (7):

$$\cos \alpha_0 \cos\varepsilon = \sin \alpha_0 \cot \lambda_1 + \sin \varepsilon \tan \phi.$$

Suppose that we have found new 'poles' and new 'East and West points', for a typical 'horizon' through the points S′ and N′, this new horizon having been fixed according to the precepts of Gazulus or Regiomontanus, their predecessors or their followers. Let us discuss the case in very general terms, and demand only that the 'horizon' cut the equator at L (as in Fig. 2) so that $VL = \alpha_0 + h$. In this case we shall have a relationship of the same general pattern as (7), but with $(\alpha_0 + h)$ in place of α_0, λ (the cusp longitude for the general case) in place of λ_1, and some new value of ϕ, say ϕ'. The obliquity will remain the same. The necessary equation will now be

$$\cos (\alpha_0 + h) \cos \varepsilon = \sin (\alpha_0 + h) \cot \lambda + \sin \varepsilon \tan \phi'.$$

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[96] Rome, Bibl. Apost. Vat., MS Pal. 1375, ff. 171v–76v (tables) and 268v–70r (modus equandi domos . . .); from Benjamin and Toomer, op. cit., n. 80. They record another table for the system in BN Lat. 10265, f. 262v; but since this precedes a Regiomontanus table it almost certainly comes from his *Tabulae directionum*. Other MSS citing Gazul's method are: MS Rastatt 36 at Karlsruhe (with a Cracow connection) and MS Lat. 599 at Cracow. See Grmek and Dadić (1976), pp. 60–3, etc.

[97] P. 40.

[98] Koch and Knappich (1959–60), vol. 2, pp. 76–7. I shall refer again in section II.27 to the horoscope in question.

This must reduce to (12), and the condition that it will do so is

$$\tan \phi' = \cos h \tan \phi.$$

This simple relationship offers an easy route to the 'Regiomontanus' method in particular. For a given latitude ϕ, we find two auxiliary latitudes:

$$\tan^{-1}(\tan \phi \cos 30^\circ) \text{ and } \tan^{-1}(\tan \phi \cos 60^\circ).$$

A table of oblique ascensions for the first of the latitudes provides us with the longitudes of the cusps of houses 2 and 12 (remembering that $\cos h = \cos(-h)$), namely as the longitudes corresponding to oblique ascensions $\alpha_0 + 30^\circ$ and $\alpha_0 - 30^\circ$, respectively. A table of oblique ascensions for the second latitude gives us the cusps of houses 3 and 11, corresponding to oblique ascensions $\alpha_0 + 60^\circ$ and $\alpha_0 - 60^\circ$.

In Regiomontanus's *Tabulae directionum* and derivative works such as Schöner's we find short tables, *tabellae,* with the auxiliary latitudes, usually called there *numeri polares.* Although the headings of these vital short tables are sometimes misprinted, and although Schöner's explanation of them is totally deficient, these tables themselves are usually accurate enough in principle for their intended purpose. There is a fundamental weakness in the method, however, in that it requires a whole range of tables of oblique ascensions, and even with them, much interpolation will be necessary. (Note that the range of tables does not imply, as some writers seem to think, that Regiomontanus and the others were concerned to provide tables for people living at very low latitudes.) Since there will be a need to interpolate *within* tables, as well as *between* tables, this will give rise to inevitable inaccuracies, sometimes quite large – for there is, after all, a limit to the number of tables and entries one can print for popular consumption. This has nothing to do with careless working: linear interpolation is simply unequal to the need, even with tables spaced at degree intervals.

As an example other than the carefully worked specimens included by standard writers to illustrate the method here explained, I give below the end-results of working by Henry of Lindhout, a competent writer on these matters, whose *Speculum astrologiae, hic est, in scientiam genethliacam sive physicam iudiciarum introductio perspicua* (etc.) appeared from the press of Wolffgang Richter, Frankfurt, in 1608. Chapter 17 gives nine nativities, by way of illustrating earlier principles of interpretation. Some are borrowed from elsewhere, but one for 'a father' and another for an unnamed friend are done for latitude 51;07° (stated), which is the latitude of his own locality (it runs through Gent and Turnhout). The cusps quoted (in degrees) are reproduced in lines one and three of the following table, with newly calculated values ($\varepsilon = 23;30^\circ$) below them.

page	ϕ	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
142	51;07°	163	193	213	233	258	300
		163	192;18	212;48	232;22	258;15	298;49
164	51;07	339;02	13;18	65;38	100;59	120;04	136;38
		339;02	15;47	67;42	101;27	121;19	138;04

Dates for these nativities (25.02.1561 and 11.07.1574) and planetary information corresponding to them are quoted in the horoscopes, but may be ignored here. The point to be observed is that when cusp longitudes are given to the nearest degree, they are to that extent highly reliable – not all astronomers achieved this, when using the *Tabulae directionum* – but when the cusps are quoted to minutes of arc, the accuracy is no better than a degree or so. In fact in the case listed above, the mean error is 1;30°, with a standard deviation (in the error) of 0;46°. Errors of the order of three degrees are not at all uncommon in other writers, which is ironical in view of the tendency of defenders of the 'rational method' to split hairs over the precise positioning of the houses.

It has to be said in this connection that the better astronomers knew the risks attendant upon the use of tables. To quote but one example of concern for the problem, there is a letter in the Bodleian MS Ashmole 423, from Jeremy Shakerley to William Lilly, in which the young writer explains how he has erected a figure, that is to say, has drawn up a horoscope, for the mid-point of an eclipse. This he has done 'according to the Doctrine of Triangles, and rules delivered in the Astrologia Mathematica of my loving friend Mr John Stephenson, . . . which way I account better than any Tables of Houses for sufficiency and exactness'.[99] Lilly's style was very different. He was certainly prepared to talk of exactness, but his work is usually characterized by haste, and approximation. To give an idea of Shakerley's working, here are his results, as compared (in the second line) with newly worked values for the latitude he names, 51;32°. (His sycophancy extended to the adoption of Lilly's latitude!) In this, and similar tables throughout, data are given in degrees.

λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
177;07	201;47	220;37	240;05	267;28	311;43
177;07	203;20	222;10	241;24	269;07	314;00

This mid-seventeenth-century example is evidently no better than those cast using tables of the traditional sort, after all. And Shakerley was an adept at splitting hairs, as he went on to show by protesting his dislike of the authors on whom Lilly had relied, in the matter of 'rectifying the ascendent of a Nativity by the Trutine of Hermes' (for more on rectification, see section I.19 below). He complained that such authors failed to take the Moon's *latitude* into the reckoning.

Finally, note that while the account offered here of the adaptation of old tables to new techniques has been orientated on the needs of Regiomontanus and his followers, it is readily adapted in turn to the needs of the Campanus–Gazulus school. Here the values of h do not increase in units of 30°, but in accordance with equation (11) of section I.2, in which it is θ that takes on the values 30°, 60°, etc. Tables were set up to produce the necessary transformations, but they left much more to the skill and effort of the astronomer, which no doubt explains why the 'rational' method was so often preferred.

I.11. *The eastern origins of the Campanus (Prime Vertical) method. Evidence from al-Bīrūnī*

Where did the method originate? I can only say that it was known in Europe before Campanus, and that when it was mentioned yet earlier by al-Bīrūnī in the *Masudic Canon*, there was no claim to originality implied.

Al-Bīrūnī (973– post–1050 AD), versatile astronomer and mathematician, not to say indefatigable collector of earlier knowledge, discussed the astrological houses at considerable length in *Al-Qānūn al-Mas'ūdī*, Treatise 11, Chapter 1.[100] I am told by Professor E. S. Kennedy that the three methods there described are these:

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[99] The letter (Bodleian MS Ashmole 423, ff. 111r–114v) is dated Pendle Forrest in Lancashire, Jan. 26 1647/8, and the time of the eclipse is quoted in it as 1648 Nov. 19^d 17^h 51^m p.m. Shakerley went on to commend Stephenson, who elsewhere in the same codex (ff. 144 sqq.) has some dreadful verse in honour of Lilly.

[100] Al-Bīrūnī (Hyderabad edn, 1954–6), pp. 1355–69. I have to thank Prof. E. S. Kennedy for telling me of this passage.

(1) 'The method of the Ancients [? *awāʾil*, ancestors].' This involves the trisection of each of the four cardinal arcs of longitude. It is what I here refer to as the Dual Longitude method.[101]

(2) 'The well known [*mashhūr*] method.' This is what I am calling the Standard method, and it is comforting to learn that al-Bīrūnī chose a similar appellation.

(3) 'The method I [Bīrūnī] prefer.' The description offered fits perfectly that already given of the 'Campanus' method.

The discovery of this last method more than two centuries before Campanus is gratifying, but it leaves us with two problems. One is the problem of transmission. Al-Bīrūnī's work, was almost entirely unknown in the West, and yet – as we shall see – the method was known to Iberian astronomers in the eleventh and to Roger of Hereford in the twelfth century. The other problem concerns al-Bīrūnī's own preference. When we turn to his *Tafhīm*,[102] we find in it a nativity for himself (4 September 973 A.D., for the town of Khwārazm, lat. 41;40°). The salient house divisions are:

λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
63;57	94;07	124;44	158	187;44	216;53.

It is easily verified that these house divisions are made according to the *Standard* method, with unusually accurate working. (The standard deviation in the right ascensions is about half a minute of arc for the night houses.) One cannot decide from internal considerations between an obliquity of 23;33° and 23;35°, but we can certainly rule out 23;51°. Al-Bīrūnī is known, in fact, to have accepted 23;35°, and from this value we derive a latitude of 41;38° (with an uncertainty of 23 minutes, given working to minutes), which is very satisfactory. The point to observe, however, is that al-Bīrūnī's preferred method does not appear to have been used for this, the most personal testimony to his belief when writing the *Tafhīm*. I doubt whether he was even in possession of a convenient algorithm for his 'preferred method', however, although he might well have known of the method of inscribing it on an astrolabe. I shall defer this question until dealing with astrolabe methods generally.[103] Here it will suffice to note that even the astrolabe method given at another place in the *Tafhīm* yields the *Standard* method of division.

I.12. *The Prime Vertical and Equatorial (fixed boundary) methods in the Spanish peninsula*

That the myth of their invention by Campanus and Regiomontanus has been so persistent is surprising, in view of the fact that these two fixed boundary methods are described in several of the so-called 'Alfonsine' books, collected together under the patronage of Alfonso X ('el sabio') of León and Castile in the thirteenth century. Alfonso's father, San Fernando, had set an example by encouraging translation from Arabic into Castilian, and Alfonso reinforced this tradition when he surrounded himself with Christian, Jewish, and Arab scholars working largely on astronomical and astrological texts.[104] In addition to translations of such important works as al-Battānī's astronomy and ʿAlī Abī-l-Rijal's astrology, there was a collective work issued under the name of *Libros del saber de astrología* (1276–7).[105] Of the many works this encyclopaedic collection contains, we shall need to refer to five in particular, and this will be done using the short English titles given in parentheses in the following list:

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[101] Section I.17.

[102] Al-Bīrūnī (ed. Wright, 1934), p. 191.

[103] Section I.21.

[104] The most weighty general biography and political history of Alfonso's reign is Ballesteros-Beretta (1963), but see also Procter (1951).

[105] Rico y Sinobas (ed. 1863–7).

1. (*The Armillary*) *Libro de las armellas*, derived from Ibn az-Zarqellu (Arzachel), with some elaboration by the translator Isaac ibn Sid. Substantially therefore from the second half of the eleventh century, but the references that interest us could be additions. Ed. Rico y Sinobas, vol. 2.
2. (*The Spherical Astrolabe*) *Libro dell astrolabio redondo*. Again done by Isaac ibn Sid, but now from unknown originals. There is little point in discussing possible sources, although a rigorous search might elucidate the paths of transmission of horoscope techniques from East to West. Rico y Sinobas, vol. 2.
3. (*The Universal Astrolabe*) *Libros de la lámina universal*. The Arabic author was evidently ʿAlī ibn Khalaf, a Córdoban astronomer who flourished in the first decades of the eleventh century. Long introduction by Isaac ibn Sid. This and the next work will be discussed in a later section (I.23) in connection with universal astrolabe methods for domification. Rico y Sinobas vol. 3. Alfonso's preface assigns the invention of the universal plate to the author, working in Toledo, and its improvement to Ibn az-Zarqellu (see 4).
4. (*The Safea*) *Libro de la açafeha*. This eleventh century work by Ibn az-Zarqellu is based on the same general ideas as are embodied in text 3. See further section I.23 below. The treatise was translated in 1255–6 by Fernando of Toledo, and revised in Burgos in 1277 by Abraham of Toledo and Bernaldo. Rico y Sinobas, vol. 3.
5. (*The Plane Astrolabe*.) *Libro dell astrolabio llano*. Author and translator unknown. Rico y Sinobas, vol. 2.

There are numerous references in the five works mentioned here to methods for casting the houses. The Standard method is explained in appropriate ways in all four. In *The Armillary* it is given to Ptolemy and al-Battānī,[106] in *The Spherical Astrolabe* to Ptolemy and Veles (Vettius Valens),[107] and in texts 3 and 4 to Ptolemy alone.[108] Al-Bīrūnī's favoured method, that of the Prime Vertical, is mentioned but none too well explained in three out of the five texts (2, 3, and 4). In all cases it is ascribed to Hermes. In *The Spherical Astrolabe*, where the description is unintelligible, it is assigned to Hermes and Ibn az-Zarqellu,[109] hardly surprising since it is included in *The Safea* by the latter author – albeit under the name of Hermes.[110] What is particularly interesting in this last case is the information in the rubric to the chapter referring to 'Abulcacim':

> De saber eguar las XII casas segund la oppinion de Hermes. por la qual obró Abulcacim Abnazamh en sus taulas en manna de cuenta. el cual punnó en las sacar. et non concuerda con la oppinion que él puso en ell astrolábio.

Abū'l-Qāsim ibn as-Samḥ was another eleventh-century writer whose work (on an equatorium) is represented in the *Libros del saber* in translation. He worked in Granada, and around the year 1025 he issued astronomical tables using Indian methods – appropriate to a follower of al-Majrīṭī, reviser of the tables of al-Khwārizmī.[111] The tables do not seem to survive, but this chapter heading is the first evidence we have of any earlier writer than Gazul having reduced the Prime Vertical method to an algorithm. We shall later find the method used on a *Granadan* astrolabe of 1304/5, where the design of the plate amounts to an algorithm of a different sort, but one by no means so difficult to master mathematically. Here again the name associated with the method is that of Hermes.

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[106] Ibid., vol. ii, pp. 60–1.

[107] Ibid., vol. ii, p. 193.

[108] Ibid., vol. iii, pp. 71 and 204.

[109] Ibid., vol. ii, p. 193.

[110] Ibid., vol. iii, pp. 209–10.

[111] Millás (1949), pp. 28–9.

These references to the Prime Vertical method are of interest in that they suggest a route for the transmission of the idea involved. Since for this method we have the earlier tetsimony of al-Bīrūnī, however, they are less precious than the evidence offered in two of the Alfonsine works for the use of the Equatorial (fixed boundaries) system before Regiomontanus – and indeed before the astronomer named in connection with it on the 1304/5 astrolabe mentioned in the last paragraph. As we shall see in section I.22 below, it is ascribed by the maker of that instrument to al-Ghāfiqī, of late twelfth-century Granada.

The two references in question – which cannot be assumed to be necessarily independent, any more than the references to Hermes and Ptolemy – name one Abenmoat. They are not without problems of interpretation. The texts are *The Armillary* and *The Plane Astrolabe*, and whereas in the former the relevant chapter is well integrated with the work, in the latter it has the appearance of an addition. (*The Plane Astrolabe* is at all events a rather fragmented text.) Abenmoat was the Castilian rendering of Abū ʿAbd Allāh Muḥammad ibn Muʿādh al-Jayyānī, an astronomer from Jaén, the name of a province in Andalusia as well as of its capital city. He is known for a number of mathematical and astronomical works, and one that concerns us is a collection of tables, the *Tabulae Jahen*. These date from the last quarter of the eleventh century (post 1079), and were translated, with their canons, by Gerard of Cremona.[112] They have an intriguing link with Regiomontanus, for the canons were printed in 1549 at Nuremberg by Johannes Montanus and Ullrich Neuber, and published by Joachim Heller (a student of Philipp Melanchthon at Wittenberg), from a manuscript that had seemingly earlier belonged to Regiomontanus.[113] Whether this work was enough to give Regiomontanus the idea for his method may be judged better when we have described the contents of a chapter from the work in question, which in the Haller edition was assigned no author, but simply went under the title *Scriptum cuiusdam Saraceni, continens praeterea praecepta ad usum tabularum astronomicarum utilissima.*[114]

Since none of the three works mentioned makes al-Jayyānī's method very clear, I shall give a synopsis of the three relevant chapters. Dold-Samplonius and Hermelink read the *Libros del saber* texts as indicating that al-Jayyānī considered the twelve astrological houses to be of equal length, and although it is easy to understand why they came to this conclusion, it is certainly mistaken. *The Armillary* is the clearest text of the three.[115] Its author instructs us to fix the horizon ring of the armillary in relation to the zodiac ring so that the ascendent degree is at the horizon. We are then to put the 'rising ring' (*la armella del leuador*) so that it touches prime vertical and horizon at the eastern and western points at which they meet:

> et despues rebuelue la armella del leuador fata que se taíe el medio cerco de la altura con la armella dell orizon sobre los dos puntos de oriente et de occidente.

We are later told to make four marks on the equator, at sixty and thirty degrees to either side of mid-heaven, and to adjust the rising ring so that it passes successively through each of them, noting on each occasion where the ring cuts the zodiac. To show that this is the method later advocated by Regiomontanus, namely the Equatorial (fixed boundary) method, it is necessary only to show that the rising ring has its poles at the north and south points of the horizon. This is how the passage quoted above continues:

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[112] Dold-Samplonius and Hermelink (1973), pp. 82–3; and Hermelink (1964), pp. 108–12.

[113] Hermelink (1964), p. 109.

[114] Dold-Samplonius and Hermelink call it *Saraceni cuiusdam de eris* on the basis of an internal heading. The volume begins with a work *De elementis et orbibus coelestibus . . . Messahalae* (etc.).

[115] Rico y Sinobas (ed. 1863–7), vol. ii, p. 59.

> Et taíarsa otrossí la armella del rectificar de la altura con la armella de mediodía sobre los dos puntos de los dos polos de la armella del rectificar de la altura. Et affirma la armella del leuador en so estado.

There are two different scales of altitude mentioned here, one with the meridian ring (*la armella de mediodía*), the other named without qualification. The former is to be arranged so that it goes through the poles of the latter – which means that the poles of the latter are on the former. The rising ring is described in ch. ix of Book I, and shown in the figure, as being pivoted around points on the horizon ring, confirming that it does indeed have its poles on the meridian ring, i.e. at the north and south points of the horizon, as the method requires.

In *The Plane Astrolabe,* the chapter describing the method of 'Abenmoat' can only be understood correctly if we first read the chapter (Book II, ch. xvii) describing the circles of times (*los cercos de los tiempos*), which are not, as they might be imagined from their name to be, circles of unequal hours. (Those unfamiliar with astrolabe technique will find further explanation in section I.21 below.) The plate described has a set of 'circles of time', each of which has the property that it passes through the north and south points of the horizon and (in principle the author would have us draw 360 of them) through the appropriate equal divisions of the equatorial circle. Every thirtieth is distinguished by its being coloured, or marked in some other special way. The finished plate will not have both poles of the horizon actually on it – the southern will fall outside the tropic of Capricorn, the conventional outer bound of a planispheric astrolabe plate. That it does appear in its entirety on the figure in the book gives that an unusual appearance.

It is these coloured lines at thirty degree intervals (in the special sense indicated – one can see here why Dold-Samplonius and Hermelink were misled) that show the cusps of the houses, as the points of intersection with the ecliptic, this having first been set for the correct ascendent.[116] This is the usual astrolabe method, in short, for the Equatorial (fixed boundaries) method.

The canons to the *Tabulae Jahen,* at least in their printed form, are more problematical, but they are of additional importance, for they show that al-Jayyānī had developed an algorithm for calculating tables of the houses on his own system, tables that were seemingly included in his collection. Chapter xxv, on the equation of the twelve houses, begins by saying that the author will not prove what al-Khwārizmī takes from Ptolemy on the question of the ascensions of the ascendent and the tenth house (mid-heaven). He then rehearses the standard method of division. This seems to be al-Jayyānī's contribution, but the text continues: 'Inquit Abumad, ego non posui ad aequationem harum domorum tabulas, quoniam modus iste non est mihi bonus in extrahendo eas, neque video ipsum conventientem ei quod exigit forma'. This suggests that the method he presented later was his own. He was anxious to integrate it with his own doctrine of rays, and here he took Abū Maᶜshar to task for his theory of ray emission (in the astrological sense of the phrase). It is not until an unnumbered chapter at the end of the work that we have the technical details, such as they are, of his system for the houses – somewhat confused because his system of 'radial ascensions' is mixed in with it. This part of his theory I shall ignore, in summarizing as best I can the procedure he asks us to follow.

[116] Ibid., p. 309.

The chapter begins in a way once more bound to mislead over the question of houses of 30 degrees. One is to take the ascension (right or oblique?) of the ascendent, reduce it by 30°, giving the ascendent of the twelfth house. (Other instructions of a similar sort follow – with 120° for the ninth, 150° for the eighth, and so on, but these we may take as read.) Later one is told: convertimus illas ascensiones in ascensionibus orbis recti ad gradus aequales . . . For all its ambiguity, this seems to mean that we are to find the ecliptic longitude corresponding (in the first case, for the cusp of the twelfth house) to a right ascension of $\alpha_0 - 30°$. We shall never be asked to use the resulting longitude, except that it is tacitly understood that the corresponding declination (i.e. that of its end point) may be found in tables from the longitude. (There are no tables, in other words, for taking one immediately from a right ascension to the declination of the corresponding ecliptic point.) Note that I have pre-empted the issue as to whether, at the outset, right or oblique ascensions were used, for it should be obvious from Fig. 2, for example, that the difference $\alpha_0 - 30°$ is precisely what we need for an Equatorial (fixed bounds) method.

The crux of the whole chapter now follows in two sentences:

> Deinde accipe declinationem illius partis, ad quam convertimus ascensiones, et accipe sinum eius, et est sinum declinationis.
>
> (I quote this trivial first sentence to show how vague is the account, as well as how the word 'pars' is used, to refer loosely to a place, or rather places, at the ends of the declination arc.)
>
> Et scias partem eius, et scias altitudinem partis decimae in medio coeli, et accipe sinum illius altitudinis, et multiplica ipsum in sexaginta, et divide aggregatum per illud quod egreditur de multiplicatione sinus declinationis partis in sinum latitudinis regionis, tunc quod egreditur est proportio sinus longitudinis gradus, ad sinum arcus qui est inter longitudinem gradus quaesiti, et inter longitudinem servatam a medio coeli.

Now using our old notation, supplemented by the letter *a* to denote the altitude of the point of the ecliptic on the meridian, and δ' for the declination we have been discussing, this sentence seems to suggest that we may write (with sines normed to a radius of 60, and writing 60 sin a as Sin a):

$$\frac{60.\ \mathrm{Sin}\ a}{\mathrm{Sin}\ \delta'\ \mathrm{Sin}\ \phi} = \frac{\mathrm{Sin}\ \lambda_{12}}{\mathrm{Sin}\ (\lambda_{12} - \lambda_{10})}.$$

(Note that here λ_{12} denotes the longitude of the cusp of the twelfth house strictly for the *present* method. See Fig. 8.) One might waste a good deal of space discussing this equation. It is wrong, but it has an air of one that has come from something better, misrepresented, no doubt (even if it was never strictly correct) in the act of translation and copying. The right hand side has fairly certainly been inverted, for example. Referring to Fig. 8, we can see that by applying the theorem of Menelaus to spherical triangle BMV, with transversal S′LCN′, we have

$$\frac{\cos\phi}{\sin\alpha}\ \frac{\sin(\lambda_{12} - \lambda_{10})}{\sin\lambda_{12}}\ \frac{\sin(\alpha_0 - 30°)}{\cos\alpha_0} = 1.$$

Although we might turn the term in $\cos\phi$ into a sine, using for instance our equation (3), this would serve no useful purpose. It seems clear that al-Jayyānī eliminated $\sin(\alpha_0 - 30°)$ by the introduction of his sine of the declination. Again, it is hard to see why, since he obviously had tables for the oblique ascensions. Were we to take the step of eliminating that term, we should do so by means of the equation

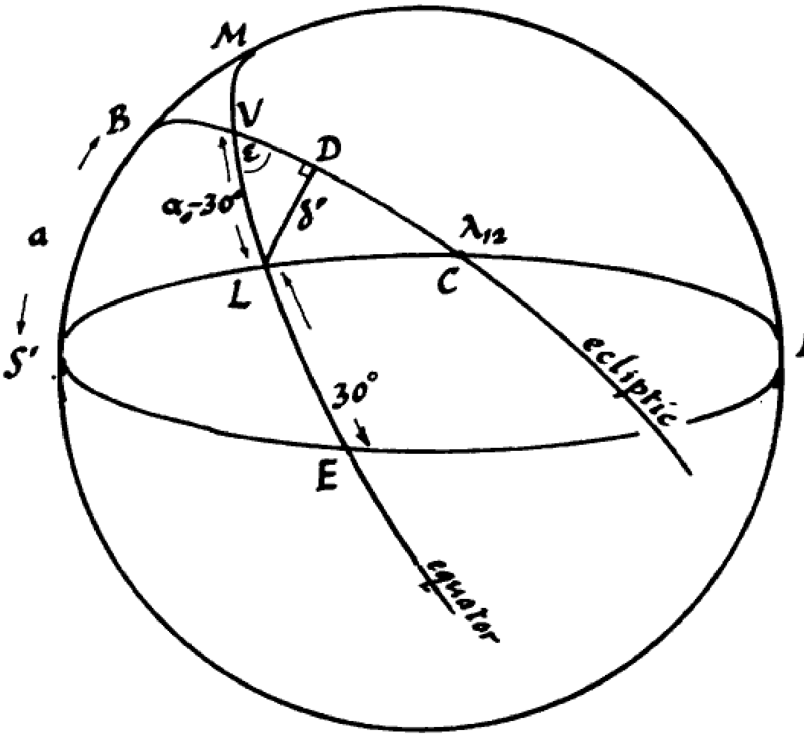

Fig. 8 To illustrate al-Jayyānī's algorithm for the Prime Vertical method. S'EN' is the right horizon, and S'LCN' is the circle of position determining the cusp C of the twelfth house.

$$\tan \delta' = \tan \varepsilon \sin (\alpha_0 - 30°),$$

which would have the effect of taking us further away from the formula suggested by the text. There is another possibility, that is, that we were intended to find the declination corresponding to a *longitude* of ($\alpha_0 - 30°$); in short, we put the right angle at D, rather than L. This provides a declination δ'', where

$$\sin \delta'' = \sin \varepsilon \sin (\alpha_0 - 30°).$$

There are some attractions in this, but it still leaves much that refuses to square with the equation of the text, as interpreted here.

Having provided the equation for λ_{12}, in terms of otherwise derivable quantities, al-Jayyānī was still faced with the problem of solving it. He distinguished carefully between two cases, one for northerly and one for southerly declination, but then added rather lamely on each occasion what amounts to the tautology 'you should do it as it is to be done'. There is no evidence here that he could effect this far from simple solution.

In conclusion, it seems quite certain that al-Jayyānī had the method of casting the houses later ascribed to al-Ghāfiqī and now known universally as Regiomontanus's method. It is possible that al-Jayyānī, a notable mathematician, developed the mathematics needed for drawing up tables for the method. This problem would be solved once and for all if the tables could be found. And finally, it is not improbable that Regiomontanus knew of his work on the subject.

1.13. *The Prime Vertical method in the West before Campanus. Roger of Hereford's table of ascensions*

To leave Muslim Spain for other parts of Europe in the twelfth century is to experience a marked slackening of pace in astronomical matters, despite the remarkable efforts at assimilation made by Adelard of Bath and a handful of his contemporaries. One who in the latter part of the century helped to change the status quo was Roger of Hereford, and it is of some interest that we find the Prime Vertical method of domification explicitly described in a work of his beginning 'Quoniam regulas artis astronomie iudicandi . . .', dating from the 1170s, and found in whole or part in a score of manuscripts. This is an important enough work to be discussed in its own right, in view of its role in conveying information on a range of problems that may be described as 'ascensional'. Near the beginning of the work, after a few preliminaries on the character of his subject, the plan of the book (which was to be in four parts), and the division of the zodiac into signs,[117] Roger devotes three chapters to the houses. In the first, beginning 'Transcursa iam duplici zodiaci . . .', he discusses an astrolabe method – essentially the same as that mentioned by al-Bīrūnī, but not at all uncommon.[118] it relies on the fact that the unequal-hour lines are designed to allow the division of the diurnal arc of the Sun into twelve parts of equal right ascension. This is the *Standard* method for the houses, and *not* that based on the prime vertical.

The next short chapter[119] is that which interests us most. The quantity of the houses, it says, may be seen by inspection of a diagram (*sic inspicienda per figuras*). This is explained in words, but the scheme is unambiguously that of my Fig. 6. The chapter is brief, and one wonders whether Roger thought that the figure he described tallied with the other explanations he was offering, which of course it does not.

There follows a 'description of a table', this being one of unequal hours corresponding to solar longitude, and a rather short explanation of how it is constructed (*ratio tabule*). The table itself, which is missing from most manuscripts,[120] is extremely interesting. Roger, as he explained, took the difference between the longest hour and the shortest to be, in angular measure, 11;40°, or 700′. If we can imagine a graph of unequal hours (in angular measure) plotted against the Sun's ecliptic longitude, it will be sinusoidal, passing through an hour length of 15° at the equinoxes, and showing a semi-amplitude of 350′ about this mean. Roger constructs his table out of what, in graphical terms, are straight-line segments. He tells us in effect that he will make up a half of the 350′ in Aries, a third in

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[117] Note that a passage here concerning the allocation of the signs to the *ninth* sphere, at f. 37r, was interpolated 'tempore factionis huius operis . . . Christi 1321'.

[118] For example, in the course of his canons to the Pisan tables (British Library, MS Arundel 377, ff. 56v–68v), Abraham ibn Ezra throws in what amounts to an astrolabe treatise giving (in this copy at f. 65v) the Standard method for the houses, using the unequal (seasonal) hour lines. These canons, dating from c.1149, are a potential influence on Roger of Hereford for the astrolabe method, although the same could be said of comparable works by Hermann of Carinthia, Adelard of Bath, Robert of Chester, and Māshā'allāh.

[119] Following Bodleian MS Selden supra 76, f. 4v, which is substantially in agreement with MS Laud misc. 644, f. 221vb, this reads as follows:

Est autem domorum quantitas sic inspicienda per figuras. Si quis consideraret in quolibet climate conjunctionem meridiani circuli et orizontis in septentrione et meridie et faceret circulum supra cenit capitis ab ortu equinoctialis ad eius iteratum ortum et hunc ab oriente divideret in equales portiones; exinde autem duceret lineas circulares a conjunctione meridiani circuli et orizontis versus septentrionem ad eorum conjunctionem versus meridiem, transitus zodiaci per has lineas domos xii faceret.

[120] For the text I follow MSS Selden supra 76 and Laud misc. 644 as before (but both are very faulty), while for the table I take MS Digby 149, f. 190r, collated with Selden supra 76, f. 5v. The latter has only the first half of the table, which is, however, symmetrical in principle with the second half.

Taurus, and a sixth in Gemini – and so on through the year, reducing by a sixth in Cancer, and so on. This is acknowledged to be Ptolemy's norm.[121] On examining his table closely (cf. Fig. 9), however, we find that it is constructed from *ten* different sizes of increment.[122] Such linear schemes as this go back to the arithmetical methods of Babylonian astronomy, and were not uncommon in the middle ages, where they occur not only in 'professional' astronomical contexts, but in ecclesiastical calendars. They are rarely then built up out of more than five or six sizes of increment. Since they are latitude-dependent, they often required more than a trivial reworking of an old table. Roger of Hereford's, with its advertised function as an aid in casting the houses, was drawn up for $M = 16^h40^m$, as we have seen, this falling between Ptolemy's values of 16^h30^m ($\phi = 51;40°$) and 16^h45^m ($\phi = 52;50°$). By straight interpolation we should get $\phi = 52°26\frac{2}{3}'$ for Hereford. It might seem that this is not a very satisfactory approach, since Roger was very much in the Toledo-Toulouse-Marseilles tradition, but he did refer to Ptolemy, as we saw. The latitude of Hereford is in fact about 52;04°, and indeed some marginal notes in MS Arundel 377 give the latitude of Hereford as 52°, as found by means of observation with the astrolabe.[123] Accepting a value of 23;33,30° for the obliquity, Roger's value for M yields $\phi = 52;45,30°$, while taking 23;30° yields exactly 52;50°. There are fourteenth-century English tables of lunar parallax[124] and for rising times and the equation of houses,[125] stated explicitly to be for $\phi = 52;50°$, implying 23;30° and 23;35° respectively for the obliquity, according to G. J. Toomer, who has conjectured that these are for Northampton, to which this latitude is assigned in another manuscript.[126] There are indications enough here of the very great difficulties we shall encounter if, in working backwards from a horoscope, we assume analytical consistency. It is then, for instance, of no consequence whether or not Roger knew a more accurate figure for his latitude.

Who first developed a full mathematical algorithm for the Prime Vertical method and how popular it became in the late middle ages, it is at present impossible to say. Much more information is bound to come to light, as greater numbers of horoscopes are analysed. We have already seen ample evidence for an awareness of the method, but I am not at present aware of a single horoscope showing evidence of its use, before the revival of interest in it due to the activities of Gazul (section I.9).

I.14. *The Dual Longitude method in the West. Robertus Anglicus*

As we saw in section I.11, the method to which I have given this name is one that al-Bīrūnī ascribed to the ancients. It is relatively easy to apply, requiring only the trisection of the

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[121] *Almagest* II.1–9.

[122] From solar longitude 1° Aries to 10° Aries, there are nine equal steps of 7;30′. With an obvious abbreviation, the table then goes as follows (note that these steps are sexagesimal parts of minutes of arc): 1° to 10° by 7;30′ – 10° to 20° by 5;40′ – 20° to 40° by 4;20′ – 40° to 50° by 4;10′ – 50° to 60° by 3;10′ – 60° to 71° by 3;05′ – 71° to 77° by 2;05′ – 77° to 80° by 1;05′ – 80° to 89° by 1;04′ – 89° to 90° by 0;04′. These of course add up to 350′, but they also fit into the broader outline offered by Roger in his *ratio tabule*.

[123] British Library, MS Arundel 377, f. 86v, in the midst of a text beginning 'Cum volueris scire diversitatem aspectus lune . . .' The altitude of the winter Sun is given as 14 degrees, the maximum day as 16;40 hours, and the longitude 24°. Roger of Hereford's tables follow, with a short canon. Note the approximative character of all this information, and how the angles are rounded to the nearest degrees.

[124] Bodleian MS Digby 68, f. 73r.

[125] Ibid., ff. 112v–115v.

[126] MS Selden supra 78, f. 67r. See Toomer (1968), p. 112. Note however that the latitude of Northampton is in reality 52;16°, that Roger of Hereford's value for M can be used to give the latitude 52;50°, and that the *Theorica planetarum* usually attributed to Roger is attributed to Robert of Northampton in MS Savile 21, f. 42 (see Haskins (1927), p. 125), so confusion of the places is not out of the question. There are no other obvious candidates for latitude 52;50° – King's Lynn, Norwich, and Oswestry seem unlikely.

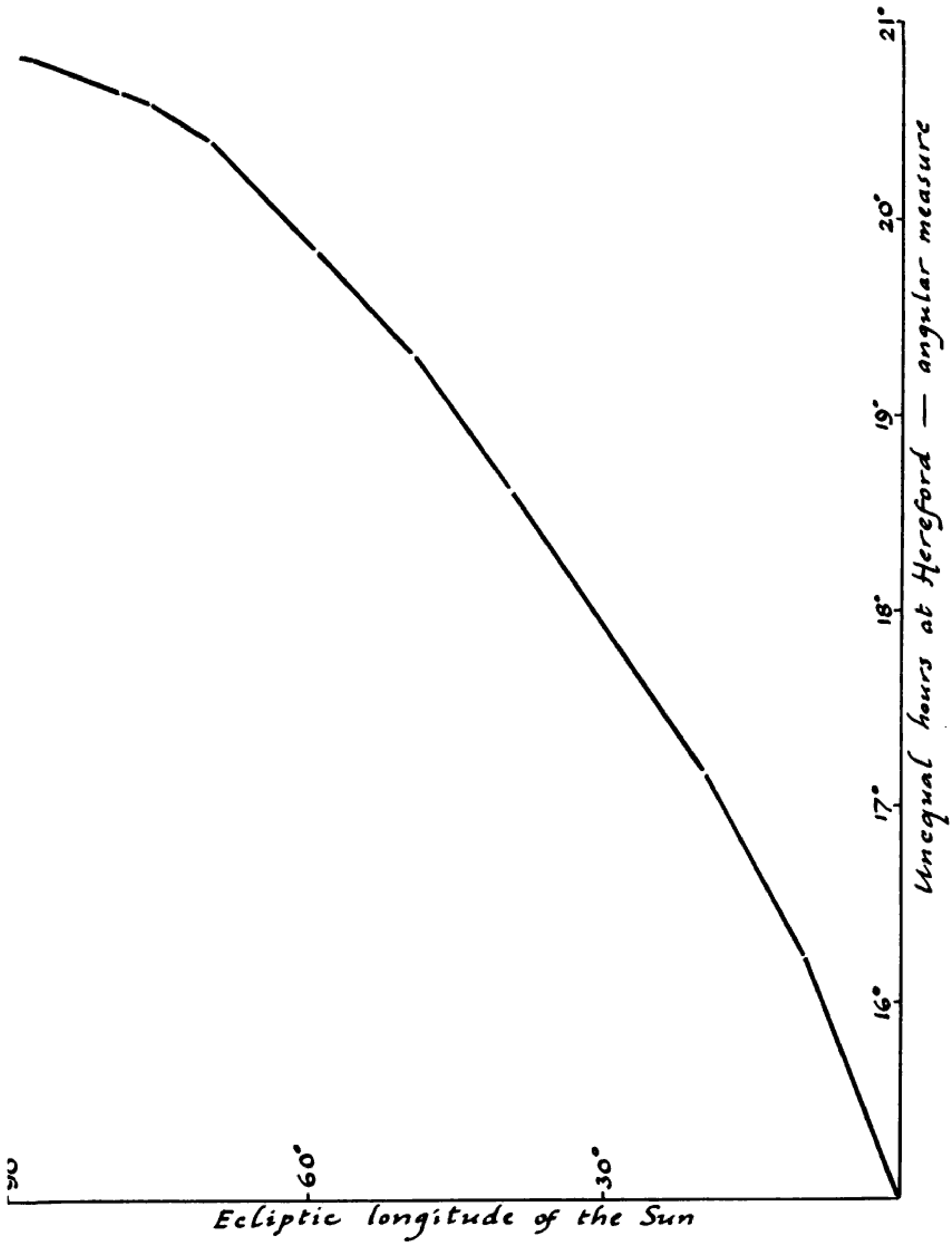

Fig. 9 Graph of Roger of Hereford's table of unequal hours.

arcs of longitude (rather than of right ascension) between the four cardinal points. I have a suspicion that some astrologers in the lower ranks might have hit on this method by accident, or rather by misunderstanding the workings of the standard method of dividing the four arcs. There is nothing on the division of the ecliptic into houses in that most common of all elementary astronomical texts, the *De sphera* of Sacrobosco (second decade of the thirteenth century ?), but when Robertus Anglicus wrote his commentary on it he included a brief but quite explicit description of the Dual Longitude method.[127] This was the subject of lectures at the University of Paris or Montpellier, around the year 1271, and thus within a few years of the commentary on the same work by Campanus of Novara. One or two writers have the idea that the Dual Longitude method was advocated by Roger Bacon in his *Opus maius,* but I imagine that they have been influenced by the comments of the editor, J. H. Bridges, which they have perhaps misunderstood. Neither Bacon's *Opus maius*, nor the *Secretum secretorum* edited and glossed by him, gives any details of the methods of dividing the zodiac into mundane houses, although they presuppose such a division, and refer to it in broad, qualitative, terms.[128] The latter work refers the reader to books of astronomy, and in particular to Albumasar's *Liber introductorius* (on which see section II.3 below).

Whatever these writers on the fringe of astrology might have advocated, the simple fact remains that almost all medieval western horoscopes, at least before the late fifteenth century, are cast according to the Standard method.

I.15. *Ptolemy, according to Valentin Nabod*

I have now surveyed the principal methods used by astrologers, at least up to the beginning of the seventeenth century, but for completeness I shall add the technique ascribed to Ptolemy by Nabod and others.[129]. Given the longitude of the ascendent λ_1, equation (2) provides the corresponding right ascension α_1, from which are found $\alpha_2 = \alpha_1 + 30°$, $\alpha_3 = \alpha_1 + 60°$, and so on to α_{12}. Finally, equation (2) may be used in reverse for λ_2, λ_3, etc. This procedure is not latitude-dependent, and λ_4 and λ_{10} are not on the meridian. If one were to assume otherwise in a particular case, and analyse the horoscope accordingly (using, for example, equation (15) on p. 16 above), the nature of the horoscope would be immediately obvious ($\alpha_1 = \alpha_4 - 90°$, etc.). As equation (15) shows clearly, but as should be otherwise obvious, this 'Ptolemaic' horoscope is *as it were of the Standard type, but for an observer at the equator.*[130]

Bearing in mind the ease with which al-Jayyānī's explanation of the Equatorial (fixed boundaries) calculation could be misunderstood (see section I.12, on the *Tabulae Jahen*), one wonders whether Nabod had been misled by reading some account of it. The divergence between explanations begins at the outset, where al-Jayyānī's requires the ascension derived from the longitude to be oblique, rather than right. The potential confusion might be at the root of a cryptic remark made in a manuscript of c.1500 and associated with Norwich – for which see the description in section II.24 below.

Nabod himself is sometimes represented as having wished to follow in Ptolemy's footsteps, but there is reason to think that he favoured the method advocated by

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[127] This is part of Lectio VI, which is wholly given over to elementary astrological concepts. It is edited and translated in Thorndike (1949), pp. 143–246 (see pp. 168–9).

[128] Bacon, *Opus maius* (ed. Bridges, 1900), vol. i, pp. 254–9; and Bacon (ed. Steele, 1920) fasc. v, p. 23.

[129] see section I.8 above.

[130] Cf. remarks made about Paulus Alexandrinus, p. 9 above.

Regiomontanus, since he cast his own horoscope on that basis. This became something of a *cause célèbre*. There is in MS Ashmole 423 a letter from Kenelm Digby to William Lilly, in which the horoscope was reproduced.[131] The essentials, as far as the houses are concerned, are these:

	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
(For 1527 Feb. $13^d18^h32^m$ p.m.)	255	268	286	324;50	27	59
	255;17	268;38	286;26	324;50	27;33	59;13

This is compatible with the latitude of both places canvassed for Nabod's birth, namely Cologne (50;54°) and Erfurt (50;56°). The second line gives newly calculated cusp longitudes according to the Equatorial (fixed boundaries) method accepted by the followers of Regiomontanus, based on a latitude of 50;55° and an obliquity of 23;30°, and taking the ascendent as norm. The accuracy of the original is greater than we tend to find with this method (see section I.10 above).

The reason for the horoscope's considerable human interest was connected with the manner of Nabod's death. Digby explains that it was shown anonymously to 'Mr Welles of Deptford, a great astrologer', who pronounced without hesitation that the owner of the scheme would die by his own sword – which Digby believed he did. He adds that Welles calculated the time (of death) correctly, and did all this notwithstanding the fact that the scheme was to be found at the end of a unique manuscript copy of Nabod's commentary on the *Quadripartitum* of Ptolemy. Digby does not seem to have known (as Welles might have known) that Campanella had published the story of Nabod's death, in his six books of astrology (dated 1629), while Tomasini had published a slightly different version in Padua, dated with the same year.[132] Both had agreed on the point that Nabod, fearing death by a sword (which he inferred from the horoscope), locked himself in his house. Campanella suggested that it was thieves, seeing the house empty and breaking into it, who killed the astrologer; but Tomasini says that there was a suspicion that rivals were responsible. We can at least say that Mr Welles was clever enough to produce the third version of the story, that known to Digby. The manuscript he was shown, incidentally, was very probably what is now MS Sloane 216 in the British Library. There, with the horoscope at the end, it is stated that Nabod was found, three days dead, transfixed by a sword, 'and it is not known whether by his own hand or another's, yet it is credible that he killed himself, since Saturn is the lord of the horoscope and of the eighth house . . .'.[133]

1.16. *Historical orthodoxy after Regiomontanus. Traditions of ascription*

We have now covered most of the historical material I am able to produce with a bearing on the origins of the different methods, and have seen enough to make us suspect that future studies are likely to lead to yet further revisions. A list of past ascriptions would be as tedious as it would be long, but there are a few general trends worth mentioning. We have seen how widespread was the tendency to give different methods to Ptolemy – who made the great mistake of leaving no clear guide as to his intentions. We have seen the repeated use of the name of Hermes. The Alfonsine books reveal a certain Iberian pride, but certainly we have no earlier name than al-Jayyānī's to tag on to the Equatorial (fixed boundary) procedure. The Roger of Hereford and Campanus passages are in a very low key, and when the latter was excerpted and copied out of its original context, this was only when the fashion for playing off one scheme against another was established – namely after Gazul. As is to be expected, central European authors took the lead, after the supposed new systems were made public property. We have already seen how names were sometimes linked with others, not to claim priority of invention, but simply because the names were famous – as John of Saxony's, in connection with the Standard method ascribed to Alchabitius, or Ibn az-Zarqellu's, associated with the method of Hermes. No doubt the same motive made Johannes Stoeffler refer to the method of 'Regiomontanus and Peurbach', which he distinguished, as it happens, from 'the older method' of Nicephorus, Māshā'allāh, and Johannes Eligerus of Gondersleven, in his *Elucidatio fabricae ususque astrolabii* (Oppenheim, 1512 and later). Jacob Koebel was another astrolabist who coupled the names of Regiomontanus and Peurbach, perhaps following Stoeffler (*Astrolabii declaratio* . . ., Paris, 1545 and later), and he was no doubt simply picking up the earlier reference, as many others must have done. I imagine that the Nicephorus intended by Stoeffler was the astrolabist Nicephorus Gregoras, whose treatise *De astrolabio*, translated by Georg Valla, had been printed in Venice in 1498. Eligerus was yet another astrolabist, and his name is sometimes attached to Ptolemy's writings on the subject.

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[131] MS Ashmole 423, f. 251. Digby uses the spelling 'Naibod', others call him Naybod and Naiboda.

[132] For further information about these two publications, see Thorndike (1941), vol. vi, pp. 121–2; but as Mr Angus Clarke has kindly pointed out to me, Thorndike did not realize that the Lyons (1629) imprint of Campanella's work is false. It was printed at Rome, as explained in Grillo (1961).

[133] Ibid., p. 123.

German pride in the 'rational' method of Regiomontanus was easily nettled. Some remarks that were widely diffused, simply because they came in Johannes Schöner's edition of Regiomontanus's *Tabulae directionum*, complain about the way Oronce Fine in Lutetia (Paris) treated 'our Regiomontanus' uncivilly, preferring Campanus and Gazulus. Schöner took up the cudgels on his compatriot's behalf over the next four pages.

Johannes Stadius is to be mentioned in this connection, if only because he seems to have thought that Ptolemy's method approximated to that of Regiomontanus. He explained at great length why he thought so, in his widely used *Ephemerides novae . . . ab anno 1564 usque ad annum 1600* (Cologne, 1570).[134] For the rest, his account of history is typical. He noted that Gaurico commended the 'method of Porphyry', which I have called the Dual Longitude method. (Stadius was best remembered not for his historiography, but for his tables. He gave tables of houses for individual degrees for latitudes 37°, 42°, 45°, 48°, 51°, and 54°, and it is noteworthy that there is appreciable ink-staining of the 51° table in John Dee's copy!)[135]

Italian writers refused to fall in with these new traditions. Pico della Mirandola accused Regiomontanus of having taken his method of equating the houses from Abraham ibn Ezra without acknowledgement.[136] Schöner's influential *Tabulae resolutae*, which in section I.10 we saw to have been an important vehicle for Regiomontanus's method, show evidence for a certain German irritation at Luca Gaurico's criticism of that method – understandable, in turn, as a patriotic counter-attack on one who had criticized the Italian Campanus.[137] Francesco Maurolico shared the same Italian tastes. Schöner, according to Gemma Frisius, turned in his old age to the method of dividing the zodiac into equal (30 degree) divisions, 'the method of Ptolemy and Firmicus'. We shall see other examples of this tendency to simplification, when we come to section II.25 – and we might add a French astrologer to the list, with Jacques Peletier of Le Mans (1517–82).[138] The Italian Giovanni Paolo Gallucci, at the end of the sixteenth century, gave the system of Regiomontanus, but added that not a few skilled astronomers still followed Alchabitius; yet in the early years of the following century, Redento Baranzani (a Barnabite, from Vercelli) listed as alternatives the methods of Firmicus, Abraham ibn Ezra, Campanus, Alchabitius, and Ptolemy.[139] This list would be hardly worth mentioning but for one fact: the name of Regiomontanus has been dropped, as Pico would have wished, in favour of Abraham.

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[134] Apud Haeredes Arnoldi Birckmanni. See f. 8r. At f. 10v he gives a worked example for the 'method of Regiomontanus and Ptolemy', for 1555 March 11.

[135] Bodleian Library, MS Ashmole 487 – notable also because Dee used the ephemeris as a diary.

[136] Thorndike (1941), vol. v, p. 333, quoting Ernst Zinner.

[137] Ibid., p. 360.

English attitudes tended to be derivative, and may be illustrated by two rather influential works, John Blagrave's *Mathematicall Jewel* of 1585, and John Dee's *Propaedeumata aphoristica* of 1558 and 1568.[140] Blagrave, who may be taken first since he was drawing very heavily on Gemma Frisius (1508–55), presented as his 'jewel' a universal astrolabe (see section I.23 below). He was not required, therefore, to develop any mathematics other than his geometrical analogues. He distinguished between: Ptolemy's system, which for him meant beginning from the ascendent and dividing the zodiac into equal parts; the Standard method, which he gave to Alchabitius and John of Saxony;[141] the method of Campanus; and that of Regiomontanus. This last, he says, he intends to follow, 'for that all menne nowe doe soe'.[142] Later in the book he wrote as follows:

> And as for the other kind of houses after Firmicus and Alkabitius and others, I utterly leave out because . . . [the instrument is filled with circles already] and also for that they are utterly rejected, and none nowe in use, but the first way after Iohn Regiomontanus.[143]

This is a useful testimony to attitudes prevalent in England in 1585, even if it is not strictly true. Interesting too is the evidence Blagrave gives for the survival of Ptolemy's rule, which we have met already in Rhetorius, and which for that matter may be found in Chaucer's *Astrolabe,*[144] that 'Everye house hath 25 degrees towardes, and five degrees of the house that went before'.[145] We must obviously take into account the possibility of a five degree shift when examining any horoscope before the seventeenth century, not to mention the period thereafter.

The text by Dee is astronomically trivial. It makes only a passing allusion to three ways of equating the houses, 'namely by meridians, by circles which cut the length of the ecliptic at right angles, and by these horizons [i.e. great circles through the north and south points of our horizon proper]'.[146] The very anonymity makes this interesting – but it also makes for modern misunderstanding. The last method is – notwithstanding a recent commentary – ambiguous as between the Equatorial and Prime Vertical (fixed boundaries) methods.[147] Dee refers to circles through the poles as meridians, so the first-named is seemingly the Standard method. The second method was evidently that which produces equal ecliptic divisions, starting from the ascendent. Perhaps he had Schöner in mind. To see how an imposing description can reduce to this (which I shall later refer to as the Single Longitude method), consider Nallino's description of Schöner's: the ecliptic is divided into four sectors, by the horizon and the great circle passing through the poles of the ecliptic and the zenith; these are then divided into three parts each, by great circles through the poles of the ecliptic. Since the ecliptic arcs so produced are of 90° each, the houses are all simply of 30° in extent. This, as I have already noted, is the *later* Schöner!

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[138] Thorndike (1941), vol. vi, pp. 102, 33.

[139] Thorndike (1941), vol. vi, pp. 158–9, and (1958), vol. vii, pp. 112–4.

[140] The 1568 edition is printed, with introduction and English translation, in Shumaker and Heilbron (1978).

[141] It was John's commentary on Alchabitius (see section II.13) that explains the widespread attribution of the method to them both. At least a dozen MSS survive (many fragmentary), and the work was printed (Venice, 1485), but only after the death of Regiomontanus.

[142] Book 3, chapters 44 ff., esp. p. 43.

[143] Ch. 47. These are Blagrave's words, not Gemma's.

[144] Book II, ch. 4 (Robinson ed., 1957), p. 551.

[145] Cf. Chaucer: 'But sothly the hous of the ascendent, that is to seyn, the first hous or the est angle, is a thing more brod and large. For, after the statutes of astrologiens, what celestial body that is 5 degrees above thilke degre that ascendith, or withinne that nombre, that is to seyn neer the degree that ascendith, yit rekne they thilke planete in the ascendent. And what planete that is under thilke degre that ascendith the space of 25 degres, yit seyn they that thilke planete is "like to him that is the hous of the ascendent." ' *Astrolabe* – ref. in n. 144 above. The opening remark about the first house being 'broader and larger' is careless – and by the final sentence quoted here we see that the last five degrees are sacrificed to [by implication] the second house.

[146] Shumaker and Heilbron (1978), pp. 154–5. I have changed the translation somewhat.

The ascriptions recorded in this section, although they could be multiplied many times over, seem to be those most widely accepted after the time of Regiomontanus. The most important of them will be found tabulated in Appendix 1, which covers the entire period discussed in this monograph.

I.17. *A typology of methods for casting the houses. Analysing a horoscope*

There seems to be no accepted typology of methods. While such is of little relevance to a history of the development of the subject, it might help us to avoid confusion as between seven fundamentally different groups, not to mention minor variants. One amusing consequence of drafting a typology is that it reveals a rough tendency for methods to become simpler with time. Methods are here given names, most of which have already been introduced. Some methods require the arcs between the ascendent, mid-heaven, descendent and lower mid-heaven to be determined at the outset. These are called the *cardinal arcs*. In all cases, apart from the idiosyncratic (0), there is a division of the ecliptic circle into houses by means of great circles radiating from the poles of the equator (N,S), the poles of the ecliptic (P,Q), or the north and south points (N′,S′) of the local horizon. These great circles pass through points dividing some circle, whether the equator, the ecliptic, or the prime vertical (the great circle through the zenith and east and west points of the horizon); and the points in question always divide the circle or its four cardinal sectors, into equal parts. If, as a result of this procedure, the cardinal arcs show up in the horoscope, the fact is mentioned. When they do show, the geographical latitude may be derived (section I.7). Note that *all horoscopes begin from the ascendent* in this account. I here describe (0) in simple graphical terms: for alternative descriptions, see section I.8.

(0) *Hour Lines (fixed boundaries) method.* The cusps of the houses are where the ecliptic is intersected by the horizon, the meridian circle, and the unequal hour lines on the sphere for even-numbered hours. Cardinal arcs show in the resulting horoscope. See Fig. 5.
(1) *Standard method.* First determine the cardinal arcs; projection circles join N,S, to the uniform divisions of the *cardinal sectors of the equator*. Cardinal arcs show in the resulting horoscope. (Figs. 2 and 3).
(2) *Dual longitude method.*[148] First determine the cardinal arcs; projection circles join K,J,

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[147] Heilbron (ibid., p. 97) seems to think the former to be 'related' to the Alchabitius method (the Standard method, as I am calling it), and reads Dee's third reference as straightforwardly to Campanus. For what the observation is worth, all the Dee horoscopes I have checked have been cast by the Equatorial (Regiomontanus) method.

[148] Producing six houses of one length and six of another (certainly Greek – Neugebauer and van Hoesen L.497 –; Islamic; described by al-Bīrūnī as the method of the ancients; known in Europe).

to *cardinal sectors of the ecliptic*, uniformly divided.[149] Cardinal arcs are detectible in the result.

(3) *Prime Vertical (fixed boundaries) method.*[150] Projection circles join N′,S′, to the uniform (30°) divisions of the *prime vertical* (colure of the equinoxes). See fig. 6. Cardinal arcs show in the result.

(4) *Equatorial (fixed boundaries) method.* Projection circles join N′,S′, to the uniform (30°) divisions of the *equator*. See fig. 7. Cardinal arcs show in the result.

(5) *Equatorial (moving boundaries) method.* Projection circles join N,S, to the uniformly divided *equator*. (The boundaries are not fixed, because division starts from the ascendent, and the points of projection are not on the horizon, as they were in (4).) Cardinal arcs do not show.

(6) *Single longitude method.*[151] Projection circles join K,J, to the uniformly divided ecliptic. Cardinal arcs do not show.

With the possible exception of (0), although even here it would be wise to assume as much, each type has a possible sub-type wherein the cusps are moved back 5° in longitude. The sub-types will here be denoted with the addition of a circumflex accent thus: $(\hat{1})$, etc. It is in general impossible to distinguish between (n) and $(\hat{n})$ without precise extraneous information about the date and *time*. One may then calculate the true ascendent by a suitable method, taking into account geographical longitude and *latitude* (ϕ), and whatever refinements (e.g. equation of time) are likely to have been taken into account in the horoscope. This presents a serious problem only with (5) and (6). For $(\alpha) - (4)$ at least a reasonable approximation to ϕ can be found from the cardinal angles λ_1 and λ_{10} (or λ_4), using equations (2) and (15) with any reasonable value for ε. Since (5) and (6) can be detected with something approaching certainty, the distinction between (0) and $(\hat{0})$, (1) and $(\hat{1})$, (2) and $(\hat{2})$, (3) and $(\hat{3})$, and (4) and $(\hat{4})$ is in principle straightforward, when the time of the horoscope is known. Since here a working error of 5° was not unusual, however, individual cases are likely to prove intractable.

As a first step in all cases we convert λ_1 and λ_{10} (or what we take to be such, from what is written under houses 1 and 4) into approximate values of α_1 and α_{10}, using equation (2). The approximation comes from the fact that we do not know the value accepted for ε.

On the detection of $(5)/(\hat{5})$ and $(6)/(\hat{6})$: the latter pair may be detected immediately (since every cusp is at the same degree of the sign). Unless ϕ is known, the true ascendent cannot be found, and (6) cannot be distinguished from $(\hat{6})$. That either (5) or $(\hat{5})$ is at issue will be evident once α_1 and α_{10} are calculated, albeit only approximately; for they will differ by 90°, or some nearby figure. It may be easily verified that if λ_1 and λ_{10} yield α_1, and α_{10} differing by 90°, then $\lambda_1 - 5°$ and $\lambda_{10} - 5°$ (the limits of the houses that one might mistake for the true geometrical cusps) will yield right ascensions always differing by a figure within a degree of 90°. To distinguish between (5) and $(\hat{5})$ is scarcely possible by this test, but is in principle possible, as for $(6)/(\hat{6})$, if the time and ϕ are *accurately* known. In actual cases this is unlikely.

For these four types/subtypes, ϕ can be found approximately only from considerations of time. As an example: if H is the hour angle of the mean sun, reckoned from the midnight line (and supposed known from the stated time) and α_5 the right ascension of the mean sun, related to the Sun's true longitude through the equation of time and equation (2), then $\alpha_0 = H + \alpha_5$. This equation allows us, for example with the help of equation (7), to find an approximate value for ϕ.

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[149] That is, we do not strictly project at all. The ecliptic sectors are simply uniformly divided. This rather artificial way of expressing the case is to make the *classification* more systematic.

[150] Described by al-Bīrūnī (and his favourite), Roger of Hereford, Campanus, et al.

[151] All houses being 30 degrees in longitude, and therefore all cusps having the same degree within the sign.

In all cases other than (5) and (6), a first approximation to ϕ can be found from equation (15).

Once (5) and (6) are eliminated from the list of possibilities, the next step is to check the lengths of the houses for method (2)/($\hat{2}$). Those between λ_1 and λ_4, and those between λ_7 and λ_{10} will be equal; and so for the others, if this method has been used, in either version.

The greatest difficulties come in deciding between (0), (1), (3), (4) and their variants. There is no simple solution. In principle, the problem is fully determinate, down to solutions for ε and ϕ, but in practice the widespread habit of using incompatible tables, and working approximately, makes the exercise pointless. The simplest approach, perhaps, is first to establish a tradition, by approximate working, and then to examine the case more clearly following the methods I advocated when introducing the four techniques. The sledgehammer approach is to run a computer programme to produce cusp longitudes for all systems with all conceivable parameters, and compare the resulting cusp longitudes with the given horoscope, choosing that algorithm which yields the closest fit. It seems only just that a scheme conceived in mystery should be decoded in the same way. The former approach, where one may see what is happening, is first to work approximatively as follows:

(i) For any horoscope before the end of the middle ages, convert all cusp longitudes to right ascensions using equation (2) with a suitably estimated value for ε: $\tan \alpha = \tan \lambda \cos \varepsilon$. Calculate the differences between the ascensions. If these fall into the familiar pattern of three roughly equal at θ, and three at $60° - \theta$, twice over, then method (1) was used.[152]

(ii) If this is not done, or if it fails to produce a plausible result, take λ_1 and λ_4 and find α_1 and α_4 from equation (2).

(iii) Derive an ideal value for λ_3 on method (1), that is, from equation (2), where $\alpha_3 = (\alpha_1 + 2\alpha_4)/3$.

(iv) Derive ϕ from (15): $\tan \varepsilon \tan \phi = \cos (\alpha_1 - \alpha_4)/\sin \alpha_1$.

(v) Derive an ideal value for λ_3 on method (4), i.e. from equation (12), modified by substituting $\alpha_4 - 90°$ for α_0:

$$\tan \lambda_3 = 2 \sin (\alpha_4 - 30°)/\{2 \cos (\alpha_4 - 30°) \cos - \tan \phi \sin \varepsilon\}.$$

This may be reduced to the alternative form:

$$\tan \lambda_3 = (a \tan \lambda_4 - 1)/(a - \cot \lambda_1), \text{ where } a = \sqrt{3} \cos \varepsilon.$$

(vi) Derive an ideal value for λ_3 on method (3), i.e. from equation (12), with $\alpha_4 - 90°$ in place of α_0, and with $\tan h = \tan 60°/\cos \phi$.

(vii) Take the solution of closest fit. If the three values found for λ_3 are close to one another, repeat the procedure for other cusps.

(viii) Only in the case where none of the solutions seems acceptable is it likely to be worth trying method (0), before 1600, since although the method was known long before then, there is as yet no known early example of its use. The iteration method of calculating horoscopes of this type (see I.8) lends itself to a simple

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[152a] If the cusps are quoted only to degrees, a scatter around the mean of two or even three degrees is to be expected.

> computer programme, and if the contents of this chapter were to be turned into a systematic programme and used to sift large numbers of horoscopes, examples might show up, but they would almost certainly be the product of astrolabe work, and hence imprecise. Those who want a rapid check on this type could first calculate a geographical latitude, and then consult a table (such as Raphael's) for what we know to be an equivalent method. Such tables are likely to be crude.

Readers thirsting for an example on which to try out the various methods might do worse than take the horoscope for the Independence of the United States, as found in Ebenezer Sibly's *A New and Complete Illustration of the Occult Sciences* (London, 1790). The cusps of the houses, from λ_{10} to λ_3 inclusive, are 253;12/ 271;00/ 290;10/ 319;49/ 20;00/ 53;00. If nothing else, this example shows its author's excellent grasp of history, placing the focus of the Revolution as he did on the latitude of London, but writing in his interpretation of events of 'that remarkable aera ... which gave independence to America, and reared up a new Empire, that shall soon or late give laws to the whole world'.[152b]

I.18. *A procedure for the ascendent and mid-heaven, knowing the time. Some conventions as to time*

It is useful to have at our disposal a simple procedure for the *astronomer's* problem of finding the cardinal points of a horoscope from the *time* – whether this is mean or true solar time, or sidereal time. We can save ourselves some trouble with new definitions if we agree to measure hour angles from the great circle through the poles and the *east point* of the horizon. By definition, *sidereal time* is the hour angle of the vernal point, and is thus measured immediately by our oblique ascension α_0 (see Fig. 2). How the time is found need not concern us. A typical method might be by a solar altitude (in which case the Sun's true longitude λ_s will be supposed known), by the altitude of some other body of known position (which will then be related to the Sun's position, whether true or mean), or by some timepiece, perhaps giving a mean time. In this last case, although the mean Sun is an equatorial rather than ecliptical fictional body, we may still suppose its longitude to be known, this being easily found from our equation (2):

$$(2) \quad \tan\alpha = \tan\lambda \cos\varepsilon.$$

Here we shall take λ_s to be the Sun's longitude, whether mean or true, and assume that the appropriate one has been selected as a datum. Similarly, the notation α_s may be used to refer to the corresponding right ascension. I use T to denote the solar time *from midnight, and in angular measure,* likewise ambiguous as between mean and true. In short, one must know in which system one means to work.

By our definitions,

$$(17) \quad T - 90^\circ + \alpha_s = \alpha_0, \text{ and}$$
$$(18) \quad \alpha_{10} = 270^\circ + \alpha_0,$$

and therefore

$$(19) \quad \alpha_{10} = 180^\circ + T + \alpha_s.$$

[152b] The illustration 'Revolution of America' comes at p. 1054 in this edition. Note an autograph letter (d.d. 28 July 1793) prefixed to the Bodleian Library copy (shelfmark Vet. A.5, d.1096), saying that Sibly does not answer astrological questions without a fee of two guineas, and that to be adept in rectifying nativities he does 'most earnestly recommend you the English Edition of Placidus de Titus [*sic*] in 3 vol.'

Since we are assuming α_s and λ_s to be known, the last equation gives us α_{10} immediately, and this can be converted into λ_{10}, the longitude of mid-heaven, by means of (2).

The quickest way to λ_1 is perhaps by the use of (17) for α_0, followed by our earlier equation (7) for λ_1. Re-written, this is:

$$(7)\ \tan \lambda_1 = \frac{\sin \alpha_0}{(\cos \alpha_0 \cos \varepsilon - \sin \varepsilon \tan \phi)}.$$

The right ascension of the ascendent might not be needed, but it is of course to be found from (2). The cardinal angles are now completely known.

Note that it is in principle possible to deduce a precise figure for the adopted obliquity (regardless of the latitude of place) from *the limits of the first and tenth houses, together with the solar longitude and the time* (preferably true local solar time). This is because equation (19), expanded with the help of equation (7) in terms of longitudes, yields a quadratic in cos ε. In practice, this is scarcely ever worth the trouble, since times are rarely given with sufficient accuracy. They are often given, for instance, to the nearest hour, or quarter.

Despite this fact, a check on the time is often well worth the trouble. Consider as an example the colophon of a horoscope of Stephanus Gradi, where the time is given in three different ways:[153] (1) [1613, Martii] $5^d 19^h 48^m 40^s$ Horol.; (2) $1^h 24^m 40^s$ P.M.; (3) $1^h 4^m 40^s$ aequatum. Putting these aside for a moment, consider the horoscope as such, in which the longitude of the Sun is given as 344;32°, while $\lambda_1 = 112;35°$ and $\lambda_{10} = 02;05°$. We know that the Prutenic tables were used, but we may take a round figure of 23;30° for the obliquity, giving us the right ascensions $\alpha_1 = 345.76°$ and $\alpha_{10} = 1.91°$. From equation (19), then, we may say categorically that the local solar time as determined by the true Sun (refraction and similar subtleties apart) would have been $13^h 04^m 36^s$ after midnight (T in angular measure being 196.15°). This is evidently to be compared with the third of the times quoted in the colophon. Had we actually taken this to be accurate, and worked back from it, we should have derived an impossibly low obliquity (23;21°) – impossibly low for the Prutenic tables, that is, even though the obliquity is there taken to vary with time.

The second of the quoted times is evidently a straightforward mean time, such as is told by a clock, and the astronomer has taken the equation of time (in our sense of the phrase) as a round 20^m, or 5°. The first time quoted remains a problem. It is clearly reckoned from very approximately six in the evening of the day before the birth, that is, the day before March 6. We are a fortnight or so from the equinox, when sunset is 6 p.m. by the true Sun ('apparent' is another accepted adjective – no less misleading). The system of Italian or Jewish hours must have been in use. Both are sometimes said to begin at sunset; some writers refer to Italian hours when time is reckoned from half an hour after sunset. Always there is the problem of refraction and twilight, not to say of subjective judgements of the latter. Presumably the word 'Horol.' refers to time by a sundial, although no astronomer would have wished to claim to read times on a sundial to seconds. Comparing (1) with (3) we can see that (1) has been reckoned from $17^h 36^m$ after the midnight between 4 and 5 March, true or apparent time. This is close to the corresponding time of *sunset* at the latitude in question (see below). Civil twilight as reckoned today (with the Sun 6° below the horizon) was approximately 29^m later, while nautical twilight

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[153] MS Vat. Lat. 6921, f. 64r. The heading is simply 'Prutenica'. For further information, see Grmek and Dadić (1976).

(the Sun being 12° below) was about 61^m later. We need not pursue the calculation exactly, to say that time (1) was sundial time on a system of hours counted from sunset, and not from half an hour thereafter. Another complication is the possibility that seasonal hours are in use, for this dial time. Since we are near the equinox, judging that particular issue is difficult if not impossible, without further documentation. A point to notice is that had the astronomer meant the time under (1) to be in seasonal hours, they would have been a mixture of day-hours and night-hours. It is worth remembering that there are very many possible ways of giving the time in a horoscope, and each must be treated on its own merits.

Stephanus Gradi (Stjepan Gradic, 1613–83) was a notable humanist, and curator of the Vatican library where his horoscope is now to be found. He was born in Ragusa (Dubrovnik), whose true latitude is 42;39°. With our usual methods for finding the latitude implicit in the adopted tables, the obliquity of 23;30° yields 44;00,11°, while 23;40° yields 43;49,06°. It is not necessary to pursue the case to see that an approximation was made, for want of a suitable table of houses. In fact on looking at the colophon we find a latitude of 43;30° quoted. We now know that this figure is the latitude ascribed to *the place of Gradi's birth* (rightly or wrongly), rather than the latitude for the *tables* accepted. This is admittedly a very small point, but it is of some biographical interest.

1.19. *Animodar, the ascendent, and the 'precise' time of birth*

The doctrine of animodar is, strictly speaking, outside the scope of this work, where we take the horoscope as a datum, and are not primarily concerned with the way the time embodied in it was determined. Some reference to the doctrine is called for, however, if only as a warning over the inconsistencies to which it may give rise.

In *Tetrabiblos* III.2, Ptolemy adverted to the difficulties that stem from ignorance of the precise moment of birth, adding that in general, only observation by means of a horoscopic astrolabe was capable of giving a scientific observer the minute of the hour. He went on to name some of the errors to be expected in sundials and water clocks, and offered a method based rather on 'natural and consistent reasoning'. One should, he said, first find the hour nearest the birth, by the 'method of ascensions', presumably meaning that one should start with an observation of the signs of the zodiac that have risen. Consider now the syzygy (new or full moon) most recent at the time of the birth. When it occurred, one of the luminaries (and two, in the case of a new moon) occupied a particular degree of a particular sign of the zodiac above the horizon.[154] Find out, by the rules of astrology already set down in the *Tetrabiblos*, whether there is one planet clearly ruling this degree in an undisputed way (using one or more of the criteria: trine, house, exaltation, term, phase or aspect). If so, then *the degree of the planet within its sign is to be deemed the degree of the ascendent within its sign*, this having been found by the method of ascensions. If there are two or more co-rulers, we are to use the one that is closest to the ascendent at the time of birth. If two or more are equally close, choose the one 'most nearly related to the centres and the sect'. But if the degree of the ruler is further from the ascendent than from mid-heaven, we are to use this degree as that of mid-heaven, and use that as a starting point in computing the other angles.

This highly complicated rule was modified by writers of Arabic astrological texts

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[154] There is some dispute as to whether Ptolemy meant us to take the position of the (visible) luminary at the time of the syzygy or of the nativity. See the footnote to the Loeb edition (Robbins ed., 1956), p. 233.

(whence the word *namūdār,* giving the Latin *animodar*), but is approximately that applied by medieval Latin writers when 'rectifying' a horoscope. The whole complexion of a horoscope, as an object for interpretation, can change by a change of a few seconds of arc in the ascendent – pushing the planets from a house with unpleasant connotations into a more benign neighbouring house, for instance. This process of rectification is often spoken of as a purely arbitrary matter, which in a horoscope meant to flatter a patron it could easily be;[155] but in principle it was a process subject to rules as rigorous as a timepiece – rationalistic but rigorous. Had it been much applied, it would have had bizarre effects on the nativities cast for the population at large, for they would have tended to share the same ascendent degree (in different signs) for periods of a month! It involves a great deal of extra calculation – for instance, of the planetary positions at the time of the syzygy as well as at the birth – and was used more for princes than for farmers. Examples for the nativity of Henry VI will be given in Part II.

There were two other ways of rectifying a nativity, that will not be introduced here, for want of any useful application. They were the so-called 'Trutina of Hermes' and the method of considering the accidents that befall the native in the course of his or her life.

1.20. *The time element, and the problem of horoscopes for more than one place*

When a horoscope is cast in connection with some event of general – rather than merely local – significance, such as an eclipse, or a great conjunction, an important historical event, or perhaps even a birth (as that of Muḥammad) deemed to be of great consequence, it is to be expected that different authors will associate it with different latitudes. From what we have seen already, this will happen in many cases as a result of a lack of suitable tables for the event (if it is a localized terrestrial event), or, as likely as not, through a poor level of awareness of the importance of latitude. One of the largest of early collections of historical horoscopes, however, that to be found in the work *Al-Kitāb al-Kāmil* by Mūsà ibn Nawbakht,[156] has many of its ninety-three horoscopes referred to more than one place. More precisely, there are three places commonly named: Baghdad, the 'centre of the Earth', and the 'centre of the fourth climate'. Ana Labarta, who has edited the work in question, translated it into Spanish, and written an introduction showing that rather more is known of the author's family than of him, has included in her edition a series of analytical tables of the data in the horoscopes.[157] From these tables some important characteristics of the collection are evident. (I refer to its contents in general by dates in the Christian era, although in the work itself the Yazdijird era is used.)

(1) The first item is dated –2129, a dozen take us up to Christ, and roughly two thirds concern events in the tenth century.

(2) The favourite sort of horoscope is one cast for an astronomical event (usually a great conjunction)[158] associated with a historical event. Of the ninety-three items, two are given to the nearest hour, nine are given to minutes, and eight are given to seconds.

(3) Planetary positions are given. These I ignore, except the solar positions. In the first forty-six cases, the Sun is at the first point of Aries. Thereafter it tends to be given for the four quarters of the year, for which times prognostications are given systemati-

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[155] Suppose that the ascendent was in fact near the beginning of a sign, and therefore near the end of the sign before it. It would be a small matter to choose the more favourable of the two signs, when placing the ascendent.

[156] Transliterated Nawbajt in the Spanish work mentioned below.

[157] Labarta (1982).

[158] See North (1980).

cally (longitudes 0°, 90°, 180°, and 270°). It is not without significance that every single case where the time is given is for the spring equinox, when time problems are least troublesome. Furthermore, all these cases are of horoscopes cast for 'centre Earth' (see below).

(4) Only one horoscope in the entire book (no. 18, for the birth of the Prophet) gives the house divisions to degrees, and this is either miscopied, or badly calculated. (I am reasonably sure that it was incompetently executed.)

(5) Fewer than half of the ninety-three items allow us to pair off values for the ascendent and md-heaven *at the same, named, place* (that is, for Baghdad, 'centre Earth', or 'climate IV'). In the solitary case where a mid-heaven for Baghdad is quoted – and note that its ascendent is given in no fewer than sixty-four cases – it produces a nonsensical 63° for the latitude of that place.

This last finding is typical of the horoscopic side of the work as a whole. Although half a dozen derived latitudes for centre Earth are close to 0°, suggesting that they at least were for some place on the equator, others are hopelessly wrong. We may derive latitudes, for instance, in every decade of degrees up to the north pole! It is important that we try to decide here between three possible explanations: an astrologer who could not calculate accurately, two or more astrologers with different aims, and corruption through miscopying. Before considering the significance attached to the quoting of ascendents for two or more places, however, we must look into the question of the *times* that are quoted.

As already noted, times of day are given for nineteen horoscopes, all when the Sun is at the first point of Aries. From equation (18) of the last section, $\alpha_{10} - 180°$ is then the solar time from midnight, in angular measure. This *exceeds* the times quoted in the horoscopes in the following table. Here the data are given to two places of decimals of degrees, the conversions to right ascension from the longitude of mid-heaven having been made with an arbitrary obliquity of 23;33° – certainly not a critical matter.

Hor. no.	Time diff.(°)
5	58.02
9	−9.06
12	210.66
18	264.74
28	190.26
29	181.07
31	181.81
33	180.00
34	179.19
38	182.59
46	179.77
50	179.44
54	179.96
66	180.44
74	3.13
78	180.26
82	185.32
86	180.72
90	179.74

The great majority of these suggest that *noon*, the astronomer's norm, was taken as the beginning of the day. Dropping no. 28, as poorly calculated, thirteen figures are close to 180°. They have in fact a mean value of 180.79°, with a standard deviation of 1.66°, suggesting a calculator of no great talent, but one whose intentions are plain enough. Some of the other data might have been borrowed, or miscalculated. Nos. 5 and 12 seem to be in the second category, while nos. 9 and 74 might stem from a source using midnight as the start of the day. The otherwise interesting no. 18, unusual in that it has a full complement of (badly calculated) houses, seems to be idiosyncratic too in the way that the day seems to have been reckoned to start at *sunset*, or near. Note that all these figures are reckoned on the basis of a mid-heaven given for the *centre of the Earth*. One might try to take up some of the differences which I have ascribed to errors of calculation, by assuming other longitudes (terrestrial) for the quoted times.

But what does this phrase mean, in the present context, and is it not an odd thing to do, to give a horoscope for more than one place, simultaneously? It is odd, in the sense that the whole point of a horoscope is to orientate the heavens with respect to the local horizon. One might conjecture that 'centre Earth' was taken to denote Arin (Ujjain), the mythical or real place through which passed the prime meridian made popular in the West by al-Khwārizmī, and that astrologers thought that events of universal significance should be referred to that place. They might well have assigned to a perfectly respectable arbitrary datum-line of longitude a mystique which it was never meant to have. This, however, is not the only possibility. There is yet another plausible meaning for 'centre Earth', namely, the equatorial place on the *same meridian as the town in which we are primarily interested*. Which of these two readings is correct?

The disadvantage of the 'Arin' interpretation is that there is no obvious equivalent place to explain away the very frequent citation of ascendents for climate IV. Are we to take it that these ascendents were for a place on the meridian of (say) Baghdad, or on the meridian of Arin, or (in what I shall call the 'single meridian' interpretation) of that town and 'centre Earth' below it? On twelve occasions clima IV is given a mid-heaven and ascendent pairing, and four times we derive a latitude within two degrees of 36°, an acceptable round figure for this climate. (In two cases the pairing gives us an *equatorial* position, so clearly some literal mistranscription has taken place here.) The other cases show no pattern, and are obviously corrupt. In no case is mid-heaven given for both 'centre Earth' and clima IV, a telling point, especially when combined with the following observation: out of the thirty cases where we combine an ascendent for clima IV with a mid-heaven for *centre Earth*, twelve of them give a latitude within two degrees of 36° and seven within four degrees of that figure. The other cases may be dismissed as corrupt or miscalculated. We can therefore say with some confidence that 'centre climate IV' was meant to be on the same meridian as 'centre Earth', and to be at the beginning of the climate, and not at its centre in the sense of being half-way to clima V.

Unfortunately, when we repeat the exercise with Baghdad, combining each of the 64 quoted ascendents with an alien mid-heaven (that is, for 'centre Earth' or 'centre clima IV'), we get no similarly consistent picture. In fact only three cases provide us with a latitude within two degrees of the standard 33;25° for the city, and they are seemingly chance coincidences. At a first glance, the other resulting latitudes are randomly scattered. It is quite clear that we are obliged to investigate the alternative hypothesis, namely that 'centre Earth' refers to some other meridian. This 'Arin hypothesis' should not be taken to imply that it has anything to do with a non-equatorial city. We use the name 'Arin' to denote an equatorial place, purely and simply to distinguish it from the equatorial place on the Baghdad meridian.

We have sixty-four ascendents for Baghdad, and only one stated value for mid-heaven. How are we to derive the others, on the 'Arin hypothesis'? Imagine the celestial sphere, with a meridian radiating from the north pole and through the zenith of 'Arin'. This will cut the ecliptic at mid-heaven for that place and (we now assume) for 'centre clima IV'. Suppose that Baghdad is taken to be n° west of 'Arin'. There will be another meridian radiating from the pole, n° to the west of the first, and cutting the ecliptic simultaneously at the point whose longitude we are seeking. The n degrees are equatorial, and we are seeking their ecliptic equivalent. We first convert the longitude of mid-heaven for 'Arin' to a right ascension; then subtract n°; and simply convert that back to an ecliptic longitude, namely to mid-heaven for Baghdad. If we do this on the forty occasions (out of the sixty-four) where it is possible, and evaluate forty latitudes for that city, and find that they come close in many cases to the required 33;25°, then we shall be able to say with some confidence that the method is the one originally adopted. (We recall that the alternative hypothesis was utterly unsatisfactory.)

So much for principles. In practice, we are faced with uncertainty over the value of n, to which different authors assigned different values, usually between 10 and 20, with most (including al-Khwārizmī, Ibn Yūnus, and the Toledan Tables) taking exactly 20. A slightly different approach will then be to evaluate an ideal mid-heaven for Baghdad, calculated on the basis of the given ascendent and a latitude of 33;25°; to find the right ascensional equivalents of this and of mid-heaven for the 'centre Earth' meridian; to take their difference, namely n°; and to decide whether there is any pattern in the forty values so derived. The value assumed for the obliquity is not critical, and we take the same figure as before.

In fact this tedious procedure leads to a result that is highly satisfactory, at least when the general disorder of the material is borne in mind. In twenty-two cases, n is in the range 14 to 26; in twelve of those cases n is in the range 18 to 22. Even extending the range from 10 to 30, we only add one more result, that is, giving twenty-three in all. Outside these limits the values obtained for n seem to be quite random – they are often very large – and we may safely dismiss them as the result of corruption in transmission or erroneous calculation. (The only possible exception to this rule is when four values come in the neighbourhood of 3°. It seems to me unlikely, but it is conceivable, that these (nos. 76, 79, 82, 93) are instances of what I earlier called the single meridian hypothesis.) If we take the narrow range (18 to 22) we find a mean value of 19;37° with a standard deviation of 1;14°. Taking the range of values between 14 and 26, the mean is 20;18°, with a standard deviation of 3;25°. (These 22 are nos. 36, 46, 56–7, 63, 65–6, 68–9, 71–5, 84–5, 87–91.) There can be little doubt that the procedure followed was the one indicated above, and there is a strong presumption based on the pattern of error we find, that the calculations were not of the highest quality, whether or not they were miscopied subsequently.

To summarize the findings of this section, which can only be asserted statistically, and which did not allow us to say dogmatically that a single author and a single method are in evidence: the horoscopes were cast simultaneously for two or three places on the Earth's surface, namely, for Baghdad, for a place ('centre Earth') on the terrestrial equator 20° east of Baghdad, and for a place on the meridian of 'centre Earth' but at or near latitude 36°, that is, the beginning of clima IV. (It has to be remembered that the precise points at which the climates begin depend on the accepted value of the obliquity.) There is no obviously important city near the place on clima IV. Interpreted strictly, its coordinates would put it in the general area of the modern Maimana. The rationale of these two- or three-fold horoscopes is unclear, but it does seem that their author might have been aiming at some sort of universality in the prognostication of world affairs.

Two final remarks are called for, in connection with the subject of this section. First, whereas we have here seen examples of horoscopes for two *places,* we shall, in a later section, come across horoscopes for two *times* – one horoscope, in effect, bordered by another, for an anniversary (sections II.6, II.22). Second, a word of warning about the *date,* when the astronomical day is in use. The astronomical day may be ahead or behind the civil day, as far as the date assigned to it is concerned. The twelfth and thirteenth century preference was to put the astronomical day behind the civil day, whilst with the increasing popularity of the Alfonsine tables in the fourteenth century, and after, the tendency was to advance the date. Regiomontanus did so, for example. Thus during the second period of twelve hours on a particular astronomical day D, the civil date on the later convention will be D + 1. During the first twelve hours, it will be D. This is a thorny subject, and it is best to consider each case on its own merits, rather than try to lay down general guidelines, especially since different conventions overlapped considerably in use.

1.21. *The common astrolabe as an instrument for casting the houses*

The planispheric astrolabe, with a history going back perhaps to Hipparchus, and certainly predating our numerical examples of the division of the zodiac into houses, is extremely well suited to the task of making at least an approximate division. While the accuracy of the rare large specimens (say over 30 cm. in diameter) might be of the order of 10′ arc in some cases, an accuracy of the order of a degree or two is typical, while for small or inferior specimens this could easily drop to five degrees or more. There are in manuscripts with horoscopes sufficiently many references to the actual use of the astrolabe for us to accept that the chapters in treatises on the instrument that deal with the houses are not included purely as a ritual. (There is reason to think that some parts of the astrolabe, for instance the hour lines on the *back,* were for the most part included by dint of tradition.)[159] I assume that the general principles of the ordinary planispheric astrolabe are understood.[160] A star map, usually in the form of a pierced brass disc (the rete), with pointers whose tips represent the stars, and with one very conspicuous circle whose outer rim represents the ecliptic, rotates around a central pin. Beneath the rete, and visible through its tracery, is a fixed plate, engraved for a particular latitude of place. The upper part of this plate, roughly speaking, is filled with a series of 'circles of equal altitude' (almucantars), while the lower part is relatively empty, but might have lines resembling more the 'radii' of a spider's web than the rings of the web. These are usually, but not always, the lines for determining the unequal hour of the day. The circles on both plate and rete are representations in stereographic projection (from the south pole on the plane of the celestial equator) of two sorts of circles on the celestial sphere: on the *plate* are those relating to local coordinates – lines of constant altitude, azimuth, and so on. The lowest almucantar is generally the horizon. (There might be almucantars for negative altitude, used in twilight calculations.)

The circles on the *rete* represent those on the star sphere. The ecliptic has already been

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[159] See North (1981).

[160] For an introduction to the subject see North (1974).

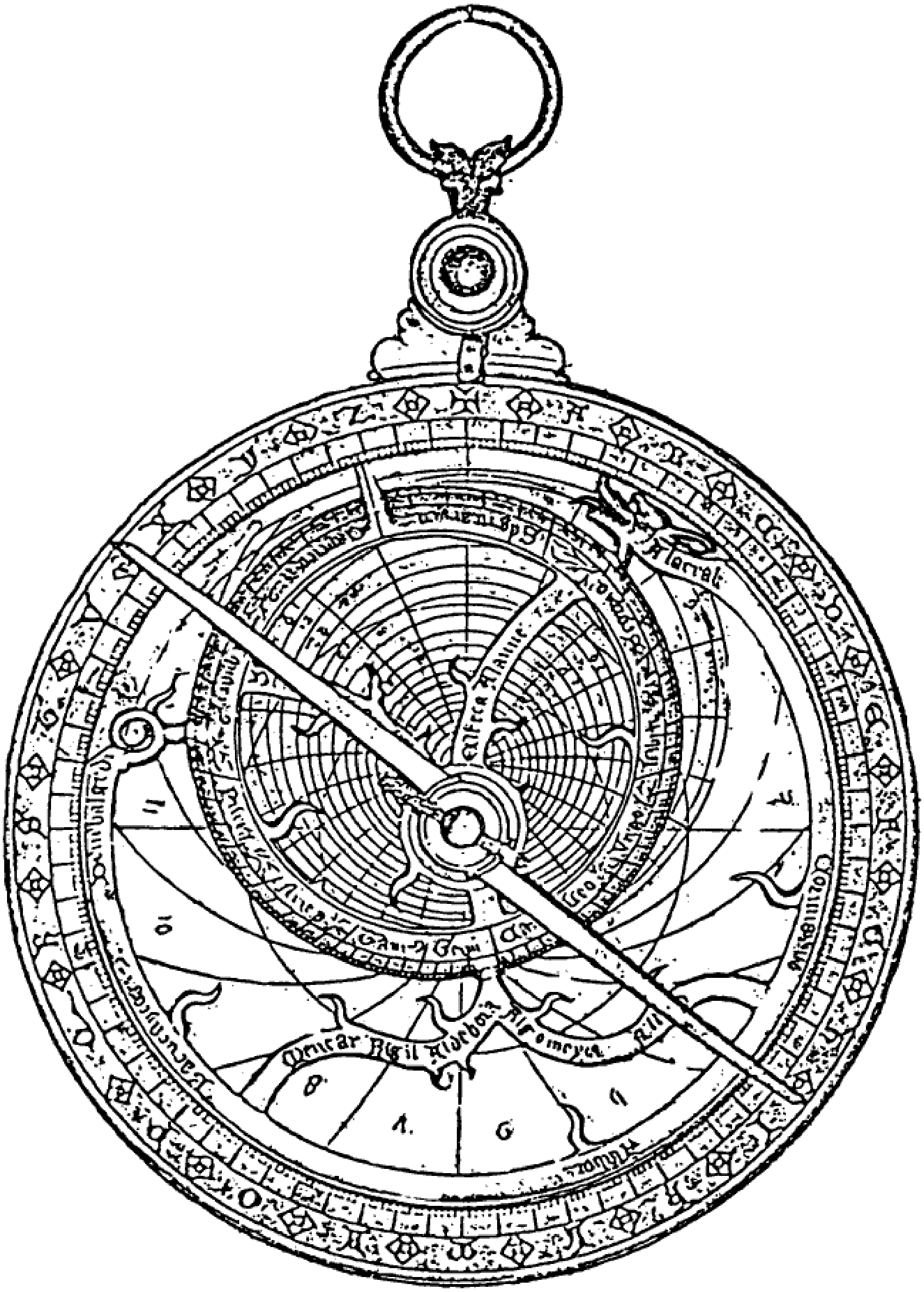

Fig. 10 Astrolabe of a style typical in English fourteenth-century manuscripts. The almucantars are visible through the ecliptic ring (upper half), while through the lower part of the rete the unequal hour lines are visible.

mentioned; there might be portions of the two ('small') circles at the tropics, the outer limit of the rete being conventionally taken as the tropic of Capricorn. The rete is of course potentially infinite in extent, since projection is from a point on the sphere itself.

The first illustration of an astrolabe (Fig. 10) shows a fourteenth-century English example, with the unequal-hour lines clearly visible through the rete. Imagine the Sun to be at the point of the ecliptic of closest approach to the north pole (centre of the astrolabe). As the rete moves round (clockwise) with the daily rotation, this point (P, say) eventually cuts the horizon line, say at P_0 in Fig. 11, and at the end of the night (geometrically defined) it does so again at P_{12}. Dividing the arc P_0P_{12} into twelve equal parts is to divide the night into twelve unequal hours for this particular latitude, and position of the Sun, namely at the summer solstice. (One does not worry about the small movement of the Sun in longitude, through the night.)

The procedure could be repeated for the case where the Sun is at any other point of the ecliptic, for example at the equinoxes (Q) or the winter solstice (R). The arc $P_4Q_4R_4$ has been constructed in Fig. 11, to show the locus of the point marking the end of the fourth unequal hour for all ecliptic points. It would be a simple enough matter to derive an

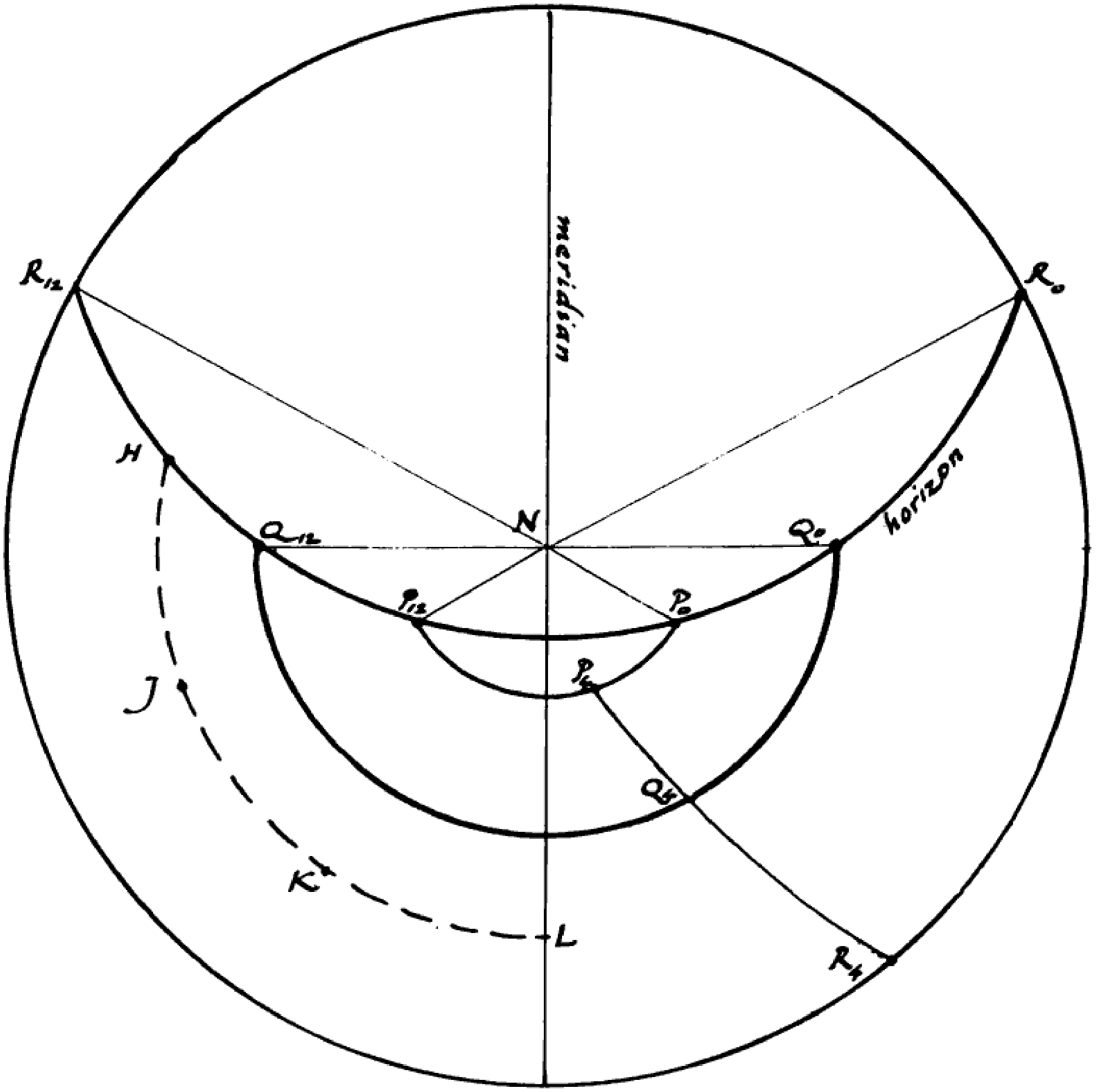

Fig. 11 The marking of unequal hour lines on an astrolabe plate.

analytical equation for this. It is reasonably well represented by the arc of a circle, and was always regarded as such by early astrolabists. (In cases where the arcs deviate from circles, this is almost certainly a sign that a bow compass was used.) Note that the lines for the daylight hours were rarely constructed, since they would have been easily confused with lines of constant azimuth. There are simple procedures for finding the day hours using the lines for night hours.

The lines for unequal hours are exactly what the astronomer needed when using the *Standard* method for casting the houses. We recall that this method is based on the trisection of the four cardinal arcs of the equator. In Fig. 11, let H represent the ascendent, the point where the ecliptic circle cuts the horizon. The broken line HJKL, the arc of a circle centred on the north pole (the pin of the astrolabe), is not the celestial equator, but if J and K divide it into three equal arcs, the straight lines NH, NJ, NK, and NL will divide the equator into three equal arcs of right ascension. By definition, J will be the end of the tenth unequal hour division, K at the end of the eighth, and L at the end of the sixth.

This gives us our first astrolabe solution to the Standard method of house division. It assumes that the astrolabe carries a radial rule, as does that in Fig. 10. Lay the rule through the ascendent H, and note the point of the rule where it meets the ecliptic (i.e. at H). Rotate the rule until it meets the line marking the end of the tenth unequal hour. Where the rule crosses the ecliptic will be λ_2, the beginning of the second house. The diametrically opposite point will be the beginning of the eighth house. Rotating the rule successively, until it meets even-numbered hour lines, it will indicate in a similar manner the other house divisions. This method may be called the *fixed rete method.*

There is a less intuitively obvious procedure that is in fact easier in practice, using a *rotating rete*. It will have been appreciated already that the meridian line (the straight vertical through N) meets the ecliptic circle at λ_{10}. Suppose now that the rete is rotated *anti-clockwise* until the point H (λ_1) meets the unequal hour line marking the end of hour ten (H is moved to J). It will have turned through the necessary angle of right ascension (namely angle HNJ) to bring the point of longitude λ_9 to the *meridian*. We may find λ_3 as its opposite – it will be on the 'midnight line', as Chaucer aptly calls it; and the method for λ_8 and λ_2 (moving H to K), and the rest, should now be equally clear.

The Standard method, which with tables must have been moderately time-consuming, is with an astrolabe straightforward and rapid, but it does require the movement of one component or the other. The great advantage of the three fixed-boundary methods is that the ecliptic is there cut by *fixed* great circles, which may be inscribed once and for all on an astrolabe plate for a given latitude, requiring nothing to be moved once the ecliptic has been set correctly for the time in question. Where the fixed circles cut the ecliptic scale, there will be the cusps of the houses. Plates inscribed according to the three fixed boundary methods (Hour Lines, Equatorial, and Prime Vertical) are shown in Figs. 13 to 16. It is a property of stereographic projection that circles project into circles, so the lines are easily constructed once three key points on each have been identified. (We have already explained the construction of the unequal hour lines, conventionally taken as circles. See Fig. 5, p. 22.)

I.22. *On distinguishing between astrolabe plates for the three fixed boundary systems. Al-Ghāfiqī of Granada, another precursor of Regiomontanus*

It is assumed that the astrolabe plate is labelled as follows: N is its centre; the east–west (straight) line ENW cuts the horizon circle EN′W in E and W; Z represents the zenith, and will be clearly identifiable on most astrolabes only if the almucantars (the lines of constant altitude) are drawn; M is where the meridian line NZ cuts the equator. The equator is a circle, centre N, passing through E and W.

The ordinary unequal hour lines will be taken as a standard of comparison for the other two systems, which then have these characteristics:

The lines dividing the ecliptic into houses must be arcs of circles which, if produced, would on *both* systems pass through N′. (They will not usually be drawn through N′, since the ecliptic could never meet them in its neighbourhood.) This is not a property of the hour lines (Fig. 11).

In the *Equatorial* (fixed boundaries) method, the lines dividing the houses (including the meridian and horizon) will divide the equatorial circle EMW into 12 equal parts. This is also true of a plate for the Hour Lines (fixed boundaries) method. Such a plate (as, for example, those illustrated in Figs. 14 and 16) can be distinguished by its property of having the three arcs (loci of P, Q, and R, in Fig. 11) *all* equally divided. A plate for the Equatorial method is shown in Fig. 15.

The *Prime Vertical* method is safely enough detected by a process of elimination. It would be very easily put to a positive test if the almucantars were drawn, since then the prime vertical would be easily constructed (EZW). The house lines should cut EZW where it meets the 30° and 60° almucantars. In cases where this cannot be easily confirmed, the use of the method may be confirmed through the fact that the nth house-line cuts the equatorial line in P_n in such a way that NP_n makes with EW an angle of size
$\text{arc tan}\ (\frac{1}{\sqrt{3}} \sec \phi)$ for $n = 2,6,8,12$,
or $\text{arc tan}\ (\sqrt{3} \sec \phi)$ for $n = 3,5,9,11$.
(See Fig. 12 for which $\tan h = \tan \theta \sec \phi$.)
The difference between the first angle, for example, and the 30° on a plate constructed for the Equatorial method, will be nearly 12° at latitude 50°, and more than 3;40° at latitude 30° – both easily enough detected, on a well drawn plate. The differences between the second angle and 60° are only slightly less.

The reason for illustrating these different sorts of plate with reference to an astrolabe by Aḥmad ibn Ḥusayn ibn Bāṣo (Figs. 13 to 16) is that this instrument gives witness to the potential use of the Equatorial and Prime Vertical methods recorded in the Alfonsine books (see section I.12 above). The Equatorial method, elsewhere ascribed to al-Jayyānī, is now ascribed to al-Ghāfiqī.[161] The astrolabe shows, too, that its maker knew the Hour

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[161] I have to thank Mr Francis Maddison for telling me of the existence of this extraordinary instrument, and for providing much of the information in the following paragraphs. The late M. Alain Brieux kindly provided the photographs of the plates. The astrolabe was once in the collection of S. V. Hoffmann of New York, later in the Smithsonian Museum, and is currently owned by Mr L. Linton of Point Lookout, N.Y. It is described and illustrated in the sale catalogue *Instruments scientifiques et Livres anciens* of M. Brieux (9 and 10 October 1980), item 162, but it was called in at that sale. Two other astrolabes by the same maker are known, one for 694 A.H. in the Real Academia de Historia, Madrid, the other for 709 A.H., formerly in the Prin collection, Paris.

The sigles for the three astrolabes in Alain Brieux and Francis Maddison, *Répertoire des facteurs d'astrolabes et de leurs oeuvres*, 1^{e} partie: 'Islam, plus Byzance, Armenie, Georgie, et Inde hindoue', Paris (forthcoming), are in order:

AHMD HSYN BASO 2 (=Linton)
AHMD HSYN BASO 1 (=Madrid)
AHMD HSYN BASO 3 (=Prin).

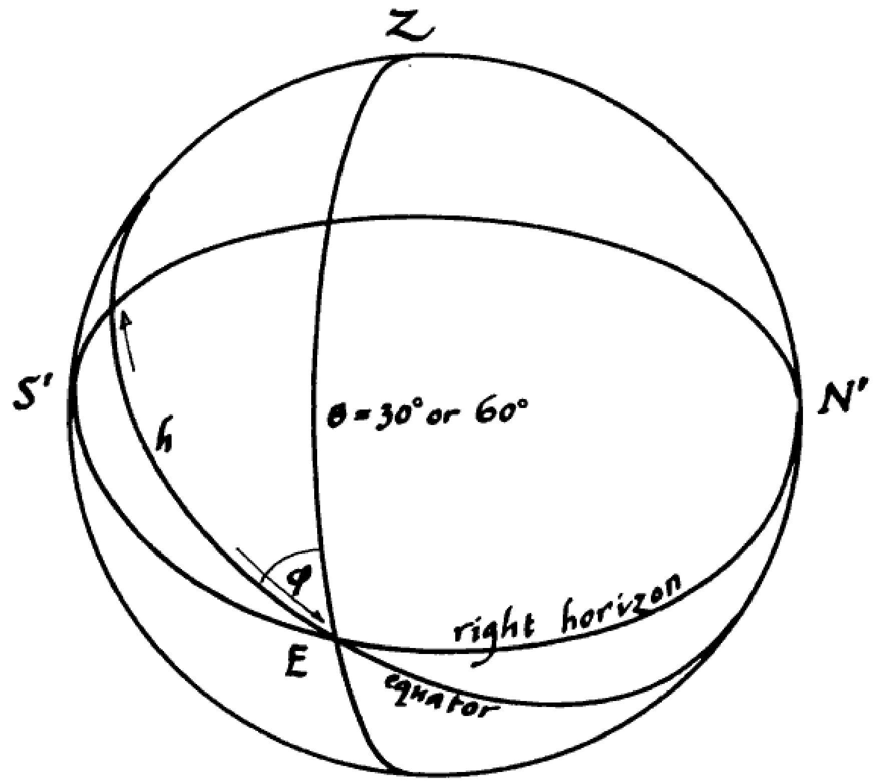

Fig. 12 The Prime Vertical construction.

Lines (fixed boundary) method as Ptolemy's, just as it had been known to Abraham ibn Ezra.

The maker has signed this extremely fine instrument, and has added the year, namely 704 of the Hejira, that is, 1304/5 A.D. There are ten plates, not all original. Three of the plates (two of them illustrated in Figs. 15 and 16) are inscribed as follows – they could have been supplemented by two others of type 2, for latitudes 36;30° and 33° (Fig. 14):

1. madhhab Hurmus li-ᶜarḍ 37 30
2. madhhab Baṭlamyūs li-ᶜarḍ 37 30
3. madhhab al-Ghāfiqī li-ᶜarḍ 37 30.

The pattern of the inscriptions is: 'the method of Hurmus, for latitute 37°30''. Hurmus is Hermes, Baṭlamyūs is Ptolemy. On examining the plates in the way explained earlier in this section, we find that the method ascribed to Ptolemy has something to do with the unequal hour lines. But how are we to know that it is the fixed boundary method, and that this is not simply a conventional plate of hours? In fact we find marked on the plate only *twelve* (not twenty-four) main divisions, and these are labelled with ordinal numbers, starting at the ascendent, and going in a *counter*-clockwise sense. This is evidence enough that we are not here dealing with an ordinary plate of hours. Note, by the way, the interesting property of the engraving of all three plates: the houses are divided into three parts, rather as the zodiacal signs are divided into 'terms' or 'decans'.

The method ascribed to Hermes is the Prime Vertical method, explained al-Bīrūnī in

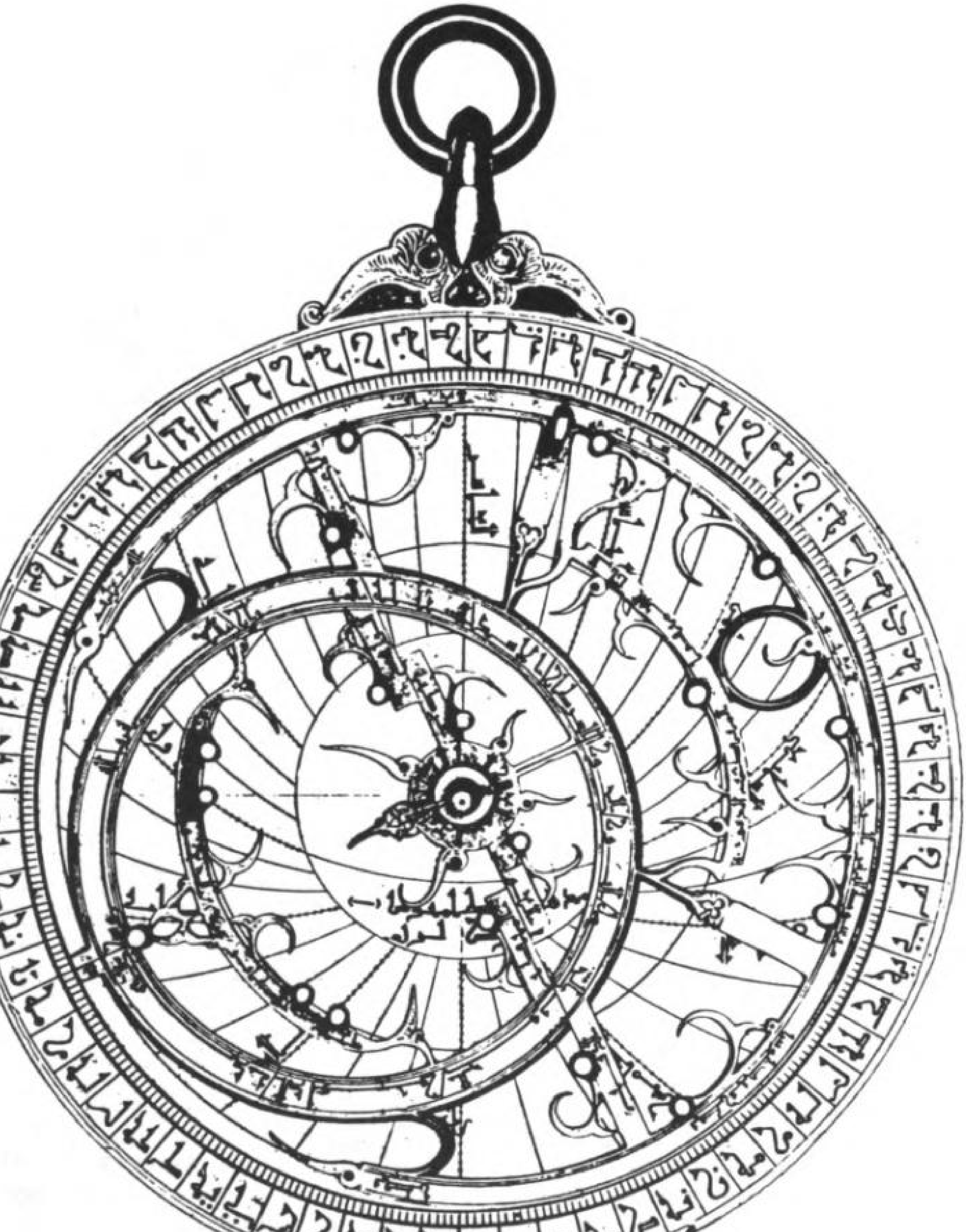

Fig. 13 General view of the front of the astrolabe by Aḥmad ibn Ḥusayn ibn Bāṣo (see pp. 60–65). The plate visible through the rete is a plate of hour lines ('for Ptolemy's method'). The following three figures are of plates for this instrument, all three being for the purpose of equating the houses. All are reproduced by kind permission of the owner of the instrument, Mr Linton.

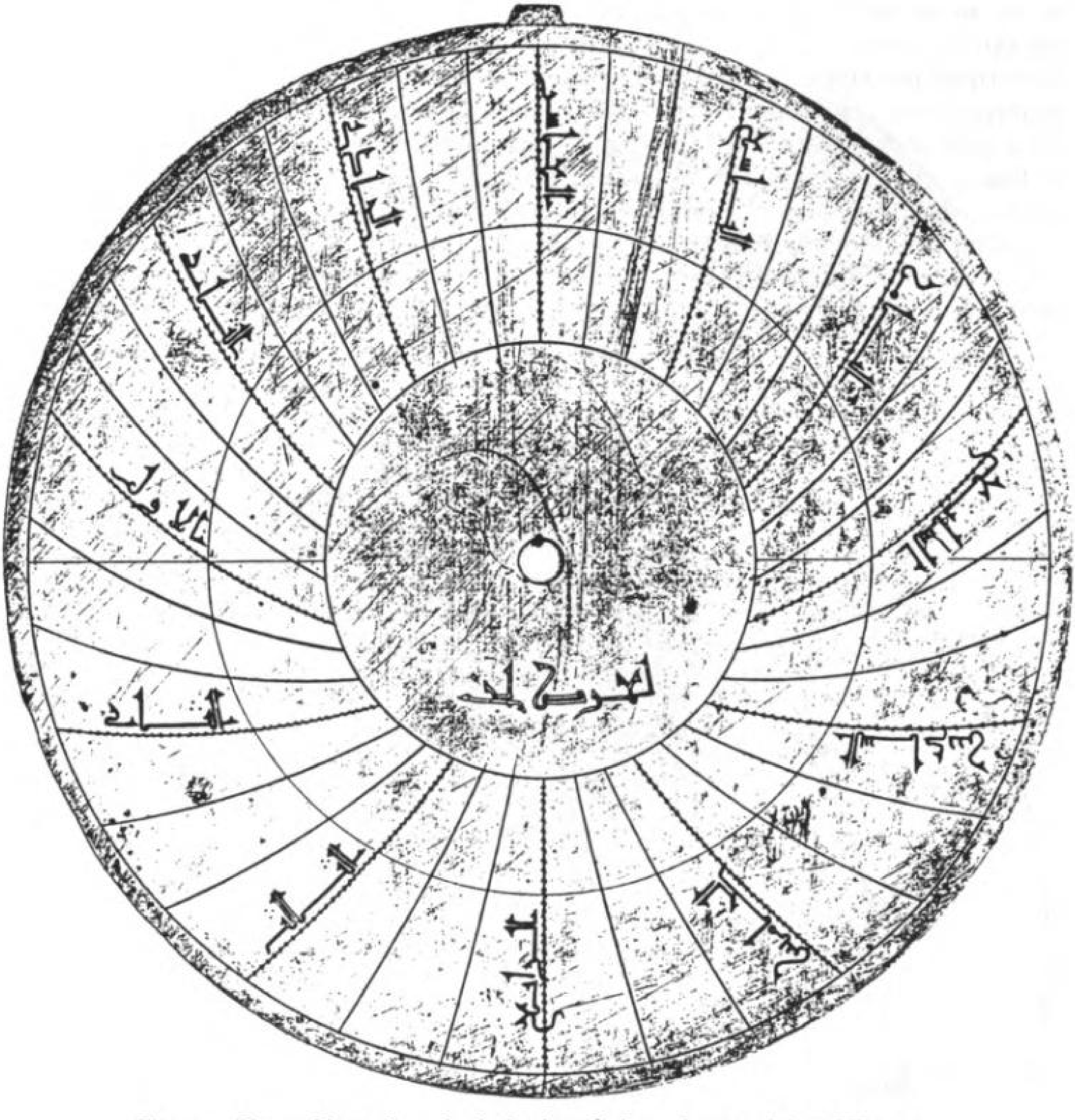

Fig. 14 Plate of hour lines for latitude 33°, from the astrolabe of Fig. 13.

his Masudic Canon,[162] and known in the West, as we now know, before this instrument was made. Ibn az-Zarqellu was supposed to have accepted it, and Ibn aṣ-Ṣamh to have had tables for it, as we have seen, although we recall that when al-Bīrūnī gave an astrolabe method for the houses, in his great work on astrology, it was the rotated rete variant of the Standard method.[163]

That the Hermes plate does indeed conform to the geometry of the Prime Vertical method is most easily (and most accurately) verified by linear measurements between key points, which in turn yield trigonometrical ratios – more reliable than measurements with a protractor, for angle ENP_n (see above). From the expressions already given for the values of this angle, it is possible to deduce an intended latitude, and in six measurements

[162] See section I.11.

[163] See pp. 33 and 59.

made on the basis of a photograph I derived a mean figure of 37.0° – this testifying to a highly skilled maker.

The third inscription is interesting as confirming that al-Jayyānī's method had its supporters, a century and a half before Regiomontanus. The maker of our instrument was not only well known as an astronomer and great instrument maker – taught by his father, according to the historian Ibn al-Khaṭīb – but was *muwaqqit* of the Grand Mosque of Granada, when the kingdom of Granada flourished under the Nasrids. We have seen already that the association of a name with a method need not imply that the man named was believed to be its inventor – witness the association of more than one name with a single method. Patriotism clearly played its part here in the naming of a fellow Granadan.

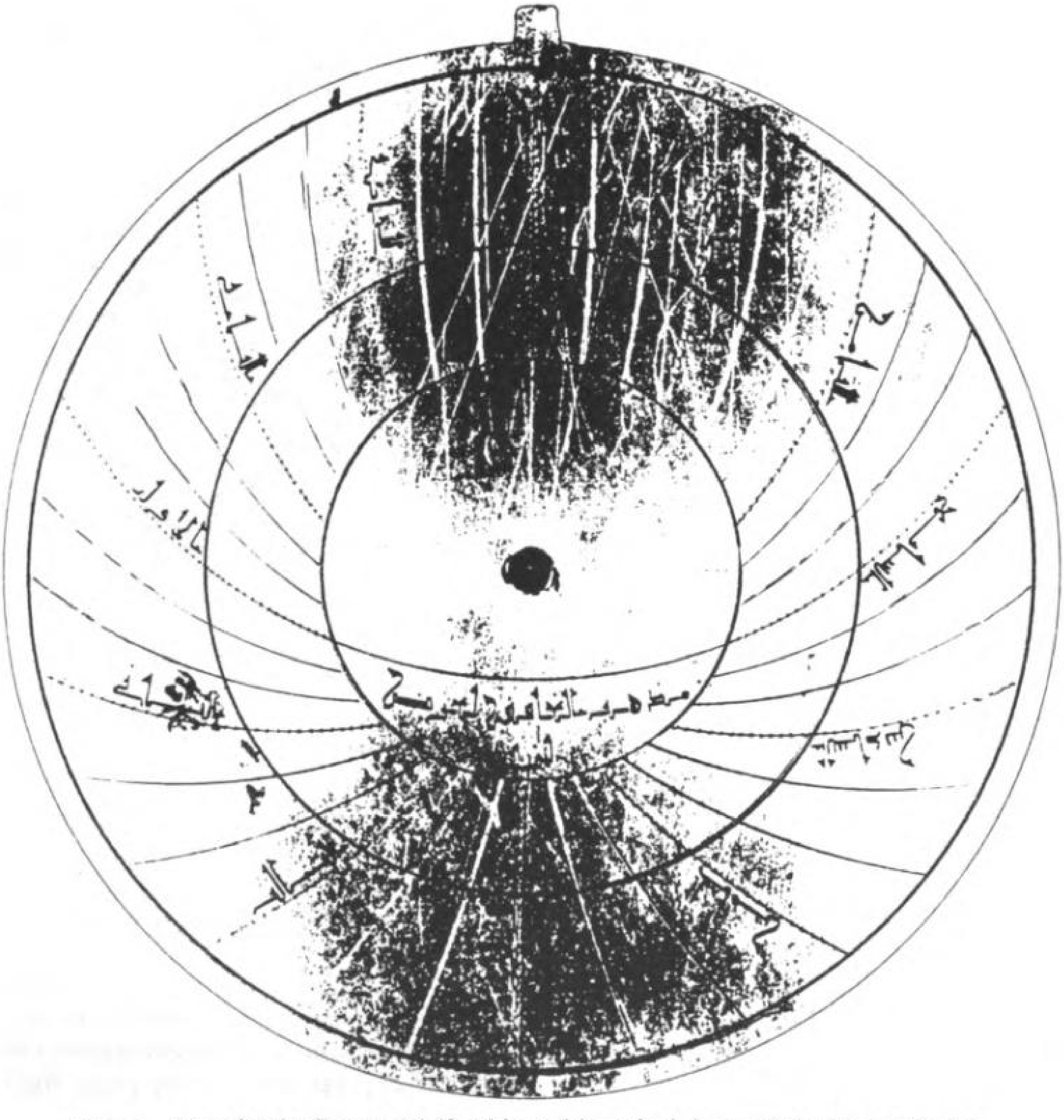

Fig. 15 Plate for the Equatorial (fixed bounds) method, here ascribed to al-Ghafiqī. From the astrolabe of Fig. 13.

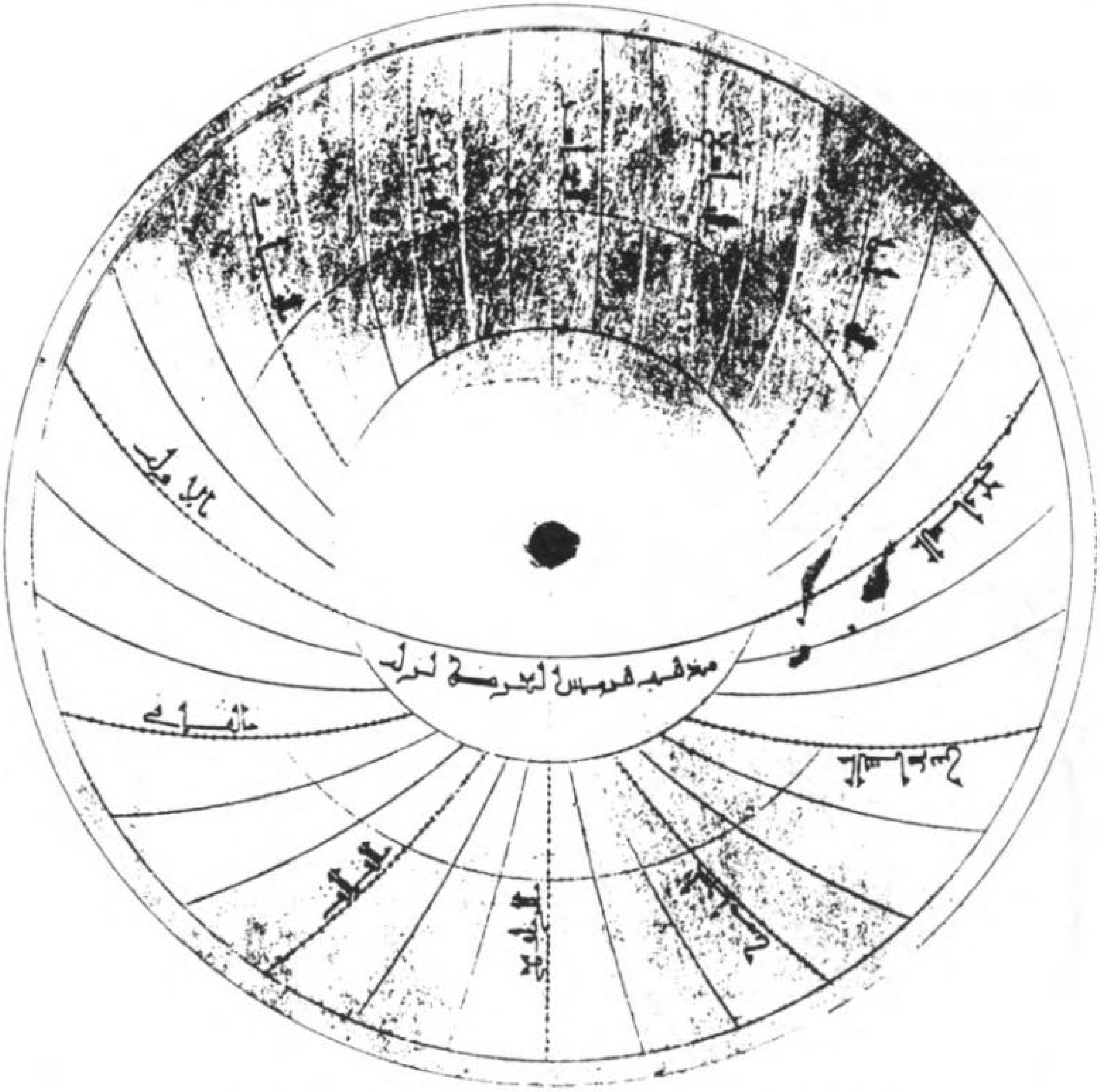

Fig. 16 Plate for the Prime Vertical (fixed bounds) method, here ascribed to Hermes. From the astrolabe of Fig. 13.

(Perhaps it was patriotism that led so many German authors to name John of Saxony in connection with the Standard method.) There are two plausible identifications of Al-Ghāfiqī: one is a Granadan tax-collector and the other, more likely, is a famous eleventh-century Cordoban astronomer Abū-'l-Qāsim Aḥmad ibn ʿAbdallāh ibn Umar al-Ghāfiqī, now best known under the name Ibn aṣ-Ṣaffār (i.e. 'son of the coppersmith'). This astronomer was a pupil of Maslama and in his turn left many influential pupils. His brother was an astrolabist of note and he himself drew up astronomical tables using Indian methods.

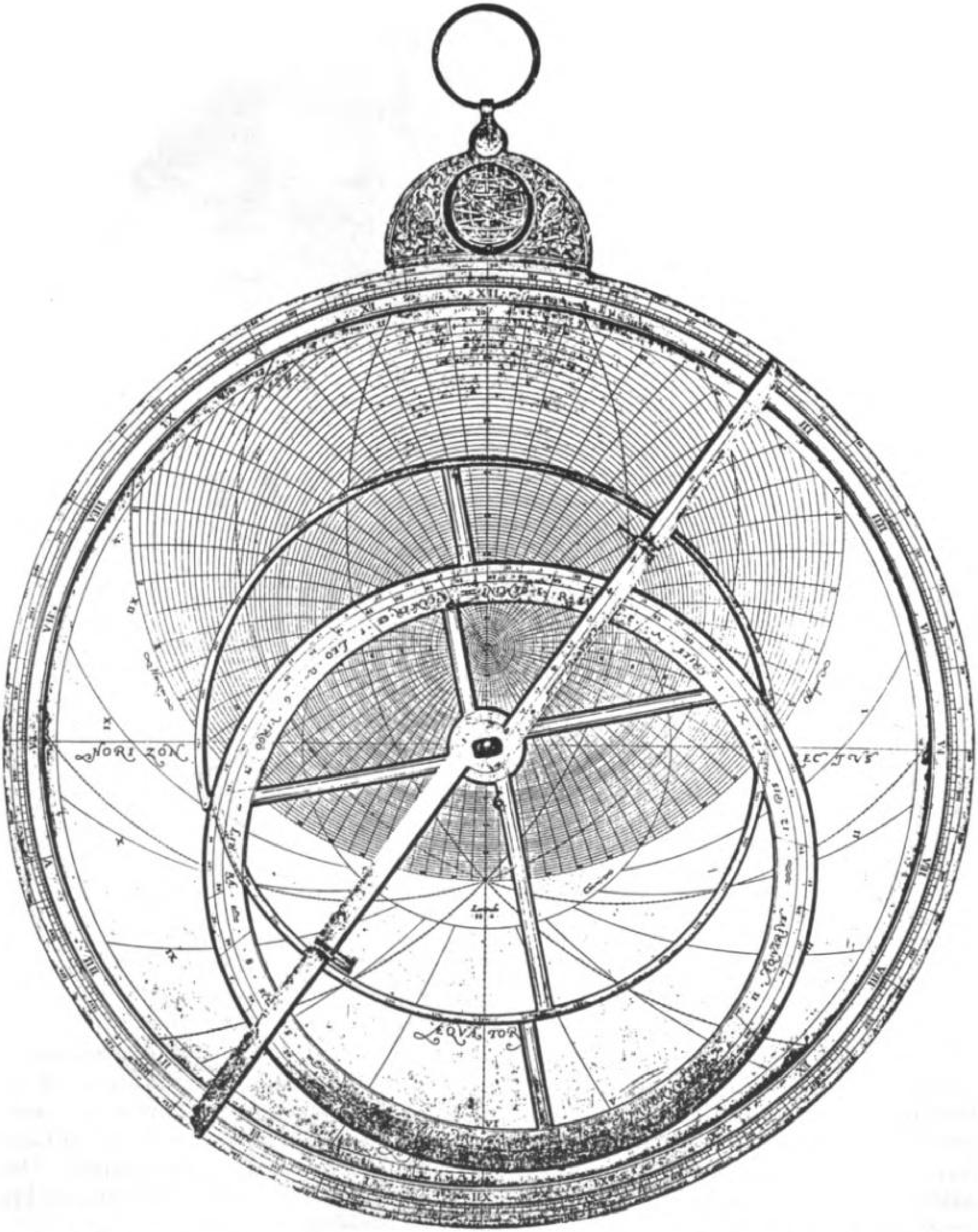

Fig. 17 The great astrolabe of Humphrey Cole (1575). Through the very basic rete of this manificently engraved and unusually large (app. 60 cm.) astrolabe almucantars for a latitude of 52° may be seen, together with lines for equating the houses according to the method of Regiomontanus (Equatorial, fixed boundaries). Note how they converge on the north point of the horizon. The south point of course lies off the area of a conventional astrolabe plate. (From R. T. Gunther 'The Great Astrolabe and other scientific instruments of Humphrey Cole', *Archaeologia*, vol. 76 (1927), Fig. 2.)

I.23. *The universal astrolabe as an instrument for casting the houses*

Two of the 'Alfonsine' tracts already cited in section I.12 deal with the universal astrolabe, or rather with two different versions of it, and for the sake of completeness I shall give a broad outline of the techniques of using them for determining the limits of the houses. The earlier type of universal astrolabe is that described by ʿAlī ibn Khalaf, and carries a rete of a special sort. The later, the 'safea' (the Latin rendering of the Arabic word for 'plate'), was without rete, but it functioned in a way best understood with reference to the earlier sort. I have elsewhere drawn attention to a solitary early Latin treatise dealing with the first type of instrument, a treatise that might somehow be connected with Abraham ibn Ezra.[164] Richard of Wallingford incorporated the safea into his albion (c.1326), and helped to popularize it in Europe, but it did not come into its own until the *Astrolabum catholicum* of Gemma Frisius in the sixteenth century, and books to which it gave rise, such as John Blagrave's *The Mathematicall Jewell* (see section I.16).[165]

The version with the rete is essentially a plate representing lines of longitude and latitude on a sphere, obtained by stereographic projection from a point on the equator. The common astrolabe is based on a projection from the south pole, and since the plane of projection is tangential to the sphere at the other pole, and inclined to the horizon at an angle depending on the latitude, the circles relating to the horizon will vary in position, according to latitude. The plane of the universal projection is tangential to the sphere at the diametrically opposite point of the equator. The general form of the resulting plate is shown in Fig. 18, reproduced from Blagrave's title page. Although half of the rete usually carried stars, and looked therefore rather like a conventional astrolabe, I shall assume in the following explanation that the rete is envisaged as a complete replica of the main plate. If made today, it would be printed on a transparent overlay.

The universal astrolabe is best seen as a device for transforming coordinates from one system to another. Neither plate nor rete should be thought of as having a fixed function. It is easy to see, for instance, how the plate might be treated as a coordinate mesh for right ascension and declination, with *any* point of its equator as the projection point (i.e. at the centre). The rete might be taken as the coordinate network for altitude and azimuth, with the east point at the centre (but not necessarily there). If the rete is laid on top of the plate and rotated until the pole of the latter is at a distance of $90° - \phi$ from the pole (zenith) of the former, it will be possible to read off the coordinates on the one system that correspond to those on the other. The origin of right ascension, that is, the vernal point, may be imagined to oscillate back and forth along the diameter of the plate. Locating its position of the moment is a question of first performing a calculation as to the time of day.

Not all coordinate sets are moving relatively. If we ignore precessional movements, for instance, we can see how, by inclining the plate and the rete at an angle equal to the obliquity, the centre now permanently representing the vernal point, we may readily transform coordinates from system (α, δ) to system (λ, β).

When there is no rete, the mental exertion needed is much greater, but essentially the procedure is the same. A point on the rete can be fixed in position, for instance, by means of a diametral arm with a sliding cursor. Together they allow us to determine a pair of rectangular coordinates. The setting of the pointer on the cursor does not need the rete's own coordinate network: it can be done with the help of the coordinate net of the *plate*. The

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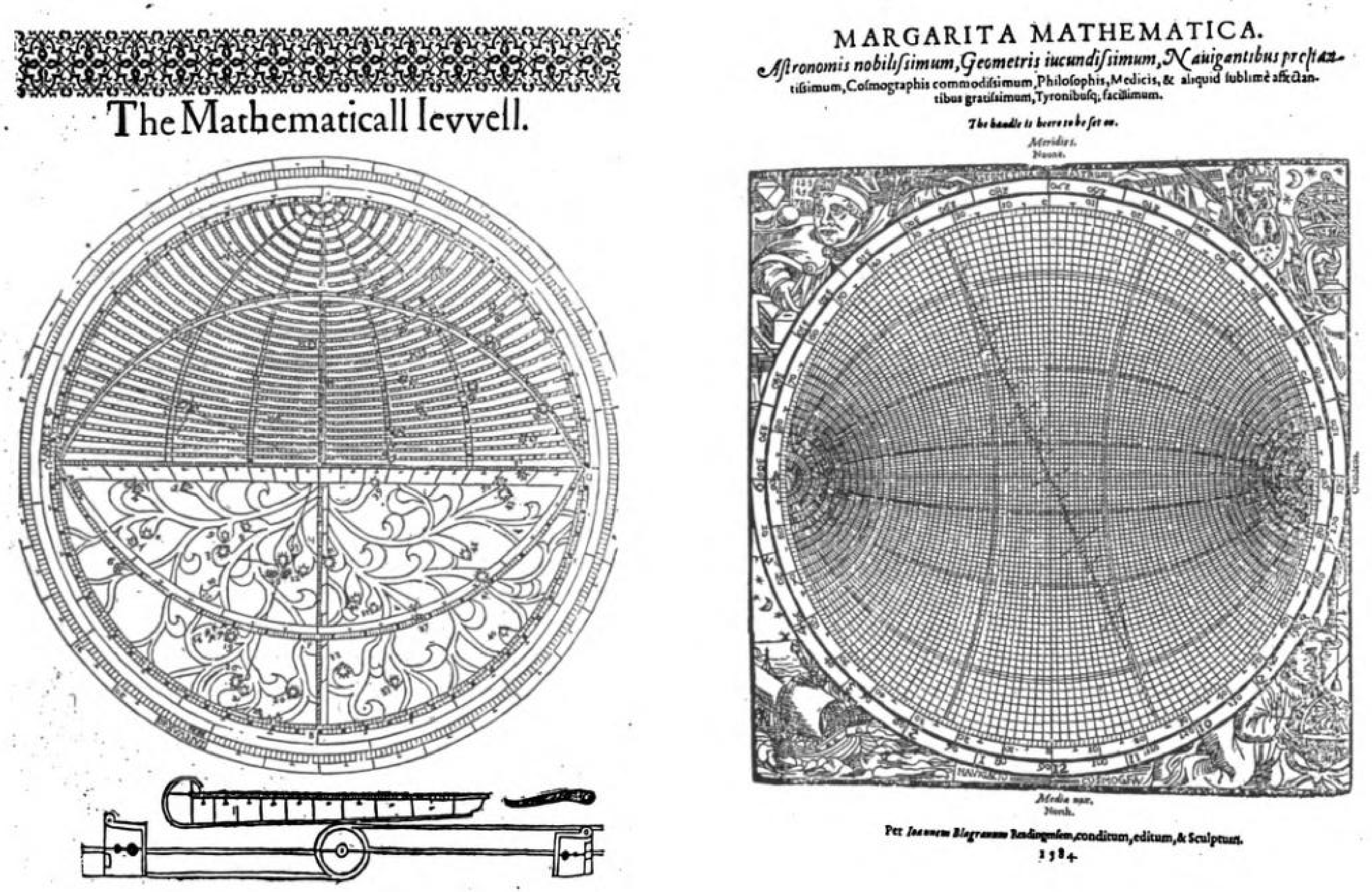
[164] See North (1976), vol. iii, appr. 27, pp. 162–4.

[165] For more historical information on Richard of Wallingford and his Iberian precursers, see North (1976), *Albion* II.24, and commentary.



The Mathematicall Ievvell.

MARGARITA MATHEMATICA.

Aſtronomis nobiliſsimum, Geometris iucundiſsimum, Nauigantibus preſtantiſsimum, Coſmographis commodiſsimum, Philoſophis, Medicis, & aliquid ſublimè affectantibus gratiſsimum, Tyronibuſq; facillimum.

The handle is heere to be ſet on.

Meridies.
Noone.

Media nox,
North.

Per *Ioannem Blagrauum* Redingenſem, conditum, editum, & Sculptum.
1584.

Fig. 18 John Blagrave's 'Mathematical Jewel', a form of astrolabe for use at any geographical latitude (see section I.23). This double spread illustration precedes the title page of Blagrave's book of 1584. 'Margarita Mathematica' (strictly Mathematical Pearl) is the Latin equivalent of the English name for the instrument, and mirrors contemporary usage (cf. Gregorius Reisch, *Margarita philosophica* of 1512). The diameters of the circles in the original publication are approx. 17 cm.

rete may then be rotated until its diameter lies at the correct angle for the exercise in question, and the coordinates read off from the plate. A skilled operator with a good imagination could work with a pair of dividers, or better with two pairs, to fix the point on the imaginary rete, and rotate the imaginary diameter.

The traditional explanations of the use of the universal astrolabe are very lengthy, but the following table should give an idea of how instructions may be given in a highly compressed form. We may drop all talk of plate and rete, for it is immaterial which coordinate set is associated with either. The notation is that of Fig. 2

Use	Pole 1	Pole 2	Angle between poles	Coord. set 1	Coord. set 2
1	N	P	ε	(α, δ)	(λ, β)
2	Z	N	$90°-\phi$	(A, a)	$(\lvert\alpha-\alpha_0\rvert, \delta)$
3	N	N′	ϕ	$(\lvert\alpha-\alpha_0\rvert, \delta)$	$(\theta, 90°-N'L)$
4	P	Z	p	$(\lambda-\lambda_1, \beta)$	$(A-A_1, a)$

(Here a is the altitude above the horizon, and p the angular distance between zenith and pole of the ecliptic.)

As an illustration of the use of the instrument for the Prime Vetical (fixed boundaries) method, consider the arrangement when the poles are P and N′, and the coordinate transformation is between $(\theta + q - 90°, *)$ and (r, 0), where q is the angle EN′P. Here the asterisk is meant to show that the coordinate is of no interest to us, while r takes on the values $\lambda_1, \lambda_2, \lambda_3$, and so on, when θ takes on the values 0°, 30°, 60°, ... The problem is that we do not know q. We can find it by first using an arrangement of type 3 in the above table. For this we have a transformation between $(\lvert\alpha - \alpha_0\rvert, 0)$ and (q, *) – in fact $(q, 90° - p)$. This is all we need to proceed to the step already outlined.

There are other ways of using the plate, notably that in which it is treated as a limited part of a plate of horizons, as though it were to be used on a conventional astrolabe.[166] This could be used, for instance, in connection with problems relating ascendent to midheaven, for a particular latitude, or for the converse problem. For our present purposes we have shown that the universal astrolabe as an instrument for equating the houses is as difficult to use as it is ingenious, and it would be surprising to find evidence that any astronomer used it regularly for the purpose. The accuracy to be expected from it (mistakes apart) is only marginally better than that with an ordinary astrolabe, given that the latter is for the required latitude. It had the theoretical advantage of universality, but this advantage was not very material, except where a client hailed from an unusually outlandish place. The richest clients never did.

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[166] For further brief remarks, see North (1976), vol. iii, app. 28, pp. 165–7.

PART II

HISTORICAL APPLICATIONS

Having made this Progresse it was easy to enquire into that of Amsterdam, which I have not yet so well confirmd by History as being more Difficult, but some of those experiences I here send you to Adde yrs unto them, for Astrology wants its History, as well as other Arts & Sciences . . .

Bernard to Lilly, 27 May 1664
MS Ashmole 242, f. 83v.

II.1. *Nine Greek horoscopes*

Having established a number of procedures for analysing the houses in a horoscope, we may apply them to some early examples, before turning to medieval practice. The early examples in question are taken from the work of Neugebauer and van Hoesen. These, it will be remembered, are numbered by their dates. Most are lacking a complete complement of houses, but many of them permit an estimate of the latitude for which they were drafted, as shown by nine examples in the table below. Note that the first three of these pre-date the tables of Ptolemy and Theon. In each case I have calculated an 'ideal' geographical latitude, following two different norms for the obliquity (23;30° and 23;50° – rounded here to allow for interpolation, or indeed even for extrapolation, if one were to suspect the presence of the 24° obliquity that is found in Indian astronomy). Derived latitudes quoted to minutes of arc are subject to the qualifications made in section I.7 on the range of uncertainty. This is not quoted here, since nothing in our brief comments below depends on it.

			$\varepsilon = 23;30°$			$\varepsilon = 23;50°$			Range in uncertainty in derived values of ϕ, rounding to half degrees (A) or minutes (B), with
Horosc. no.	λ_1	λ_{10}	α_1	α_{10}	ϕ	α_1	α_{10}	ϕ	$\varepsilon = 23;50°$
L 40	114	10	115;54	9;11	36;19	115;57	9;10	36;02	35;14 to 37;41 (A)
L 75	347	265	348;03	264;33	51;31	348;50	264;32	50;57	47;24 to 53;01 (A)
95	115	10;30	116;57	9;39	37;30	117;01	9;37	37;13	36;25 to 38;50 (A)
L 380	325	245	327;18	243;03	23;06	327;22	242;59	22;20	18;57 to 24;08 (A)
L 412	8;19	274;42	7;38	275;07	37;11	7;37	275;08	36;28	36;27 to 36;30 (B)
L 440	323;30	245;03	325;50	243;06	27;22	325;54	243;02	26;38	26;38 to 26;38 (B)
L 486	26	280	24;06	280;53	52;10	24;03	280;55	51;37	50;33 to 53;05 (A)
L 516	42	293;30	39;33	295;22	41;30	39;29	295;25	40;51	39;50 to 42;28 (A)
L 621	200	112	198;27	113;47	33;57	198;25	113;50	34;05	28;16 to 36;27 (A)

Comments (NvH = Neugebauer & van Hoesen, *op. cit.*)

L 40 Clima IV (Rhodes) was $\phi = 36;00°$. Conjectured to be for S. Spain (NvH, p. 80).

L 75 Perhaps miscalculated or miscopied ($\phi = 51;30°$, with $M = 16{:}30^h$, is Ptolemy's S. Britain). Note, however, the great range of uncertainty: 42;35° to 56;18°, or 48;50° to 55;12° with rounding down only, taking $\varepsilon = 23;51°$.
95 Cf. L 40. Ptolemy's 12th parallel is at $\phi = 38;35°$ (Smyrna), after Rhodes.
L 380 Clima III (Soene) was taken as $\phi = 23;51°$ by Ptolemy. The text attests this clima.
L 412 For Proclus' death (at Athens; b. Byzantium), but fits Rhodes closely.
L 440 For the poet Pamprepius, b. Panopolis in the Thebais (NvH, p. 141), cf. Ptolemais Herm., 8th parallel, $\phi = 27;12°$.
L 486 Associated with an Alexandrian prefect, so assumed miscopied or miscalculated.
L 516 Clima V (Hellespont) was $\phi = 40;56°$.
L 621 Supposed, for textual reasons, to be for Clima V or Byzantium, and to be in error through use of the astrolabe. See NvH, pp. 159–60. Compare, however, my comments on the problem of rounded data, in connection with this example, at p. 18 above.

Right ascensions are first found from equation (2) of section I.2, and then latitudes from equation (5). No pairs of coordinates offer an example of the 90 degree difference characteristic of methods (5) and (6) – the Equatorial (moving bounds) and *Single Longitude* methods. *The Single Longitude method* was actually used in another example in the work in question, namely L.487.[167] Although our sample is a small one, accompanying texts and other considerations do allow a certain degree of verification of the accuracy of the documents. In two cases this is reasonable. Four are of dubious appropriateness to the places for which they seem to have been intended, and three are poor, as they stand. One poor example, L.621, occurs in a text where it is expressly stated that an astrolabe was used. This is the example taken in section I.7 to illustrate the limits of the method for finding latitude.

The two horoscopes in which all twelve cusps are given are L.428 and L.497, both of which have already been discussed briefly.[168] The principles of calculation are unambiguously explained in the associated texts.[169] The former horoscope is, as we saw, of type (î) – the *Standard method* with the five-degree shift. The latter is such that the longitudinal extents of the houses are equal for houses 1,2,3,7,8,9 and again for the remaining houses – in fact method (2) on my list in I.14, the *Dual Longitude method*. The use of Theon's tables, with different programmes, of course, gives us acceptable house divisions for both, the first horoscope being for clima V, the second for Alexandria.

II.2. *Māshā'allāh's historical horoscopes and nativities*

Medieval horoscopes were often lifted unacknowledged from Eastern sources, as is evident from deduced latitudes and dates, and examples found to be taken from the writings of the eighth-century Jewish astrologer Māshā'allāh are not uncommon. Some of these may be considered briefly. The problem is complicated by the fact that he in turn borrowed some of them from earlier writers, while in most cases our methods are of little use for latitude, since the houses are given only to signs. He used pre-Islamic royal Iranian astronomical canons (of the Sasanian dynasty) that are no longer extant. E. S. Kennedy and D. Pingree have published material in their *The Astrological History of Māshā'allāh*[170] that allows a number of useful inferences to be drawn from this early material, including

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[167] The ascendent longitude is 180;41°, and mid-heaven 90;41°.

[168] See p. 6 above.

[169] Neugebauer and van Hoesen (1959), pp. 138–40 and 152–7.

[170] Kennedy and Pingree (1971).

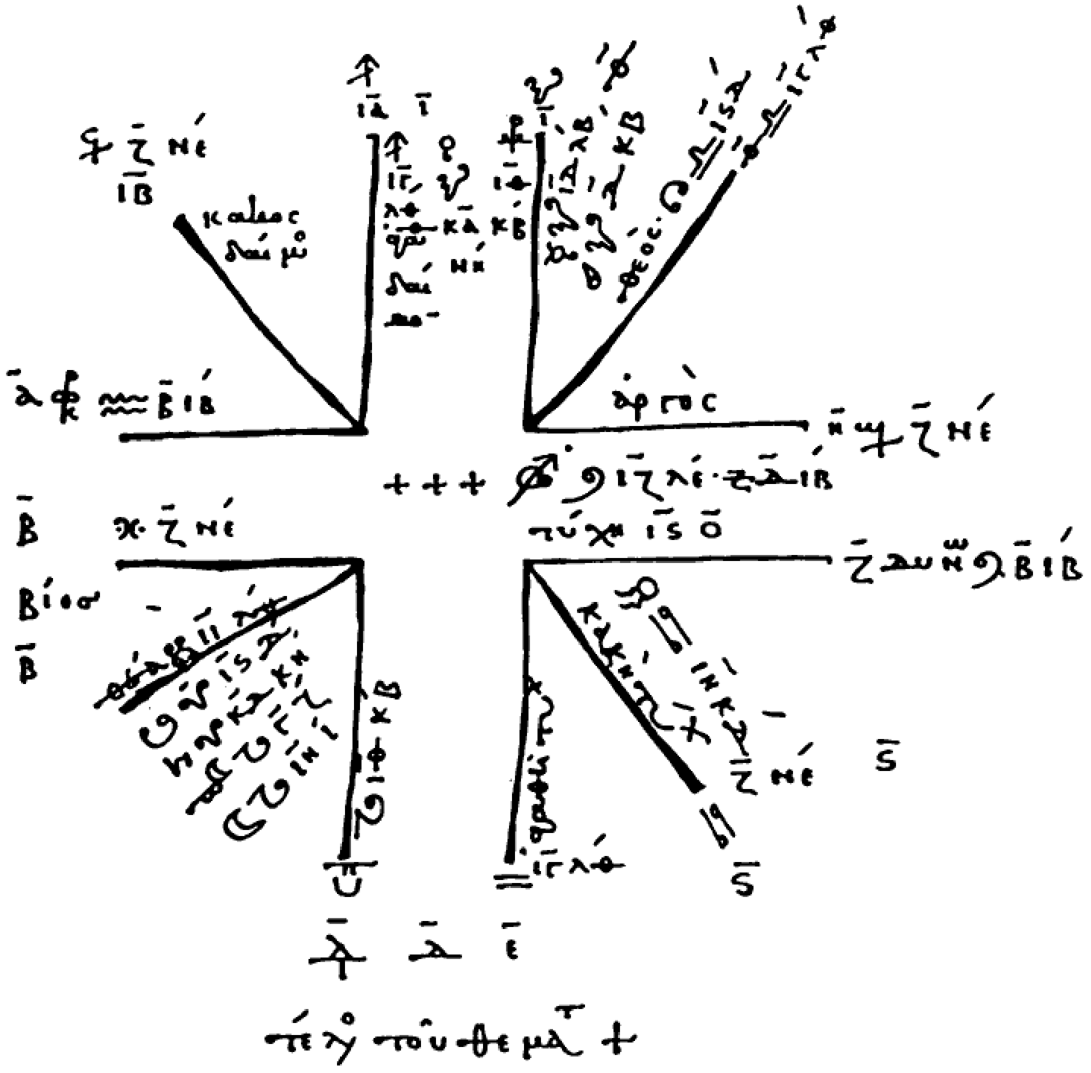

Fig. 19 Horoscope from a literary source, dated 497 October 28 by Neugebauer and van Hoesen (1959; pp. 152–7).

numerous horoscopes, mostly concerning important events in world history, such as the Deluge and the birth of Christ. Of sixteen such horoscopes in the *History*, all give a precise degree for the ascendent (in three cases also the minute), but supply mid-heaven and the other house divisions only to signs, except in a single case ($\lambda_1 = 259°$ and $\lambda_{10} = 7;47°$ for the Deluge).[171] If we take an obliquity of 23;51′, this suggests a geographical latitude of 37;09°. (Compare remarks against no. 40 in the previous table.)

There are seven more interesting horoscopes in a work of which the original Arabic is now lost, but which survives in an apparently unique Latin 'Liber Mesellae de nativitatibus', edited by Pingree in the same volume. These are horoscopes for which the degrees of *all* house divisions are given – they are among others for which this is not true. In the following tabulation, the column for ϕ is based again on an obliquity of 23;51°, since it appears that the first is taken from the *Pentateuch* of Dorotheus of Sidon while the others of the precise set were taken from an unknown sixth-century Byzantine source, whose author has drawn somewhat on Rhetorius.[172] Later, Māshā'allāh's pupil Abū 'Alī al-Khayyāṭ borrowed them again, and they were printed in Joachim Heller's edition *Albohali Arabis . . . De iudiciis nativitatum* (Nuremberg, 1546), chapter 7.

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[171] Ibid., p. 41.

ref.	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	α_{10}	α_{11}	α_{12}	α_1	α_2	α_3	ϕ
3·1	310	349	29	66	87	107	312;32	349;55	26;53	64;03	86;43	108;29	42;41
3·2	276	305	337	12	43	69	276;33	307;26	338;47	11;00	40;28	67;14	42;35
3·8	127	154	183	211	244	275	129;27	155;58	182;45	208;47	241;56	275;28	41;04
3·9	333	14	53	89	99	130	335;01	12;51	50;31	88;54	99;49	132;32	42;30
3·10	292	325	4	41	66	88	293;50	327;22	3;40	38;29	64;03	87;49	42;36
3·11	103	130	159	191	223	254	104;10	132;32	160;39	190;05	220;28	252;36	42;38
3·12	342	23	62	97	117	139	343;27	21;13	59;50	97;39	119;07	141;31	43;05

The surprising thing is that five out of the seven are highly consistent, yielding a mean latitude of 42;36°, while even the mean of all seven derived latitudes is 42;27°.[173] There is a strong presumption, therefore, that at least five and even seven were *recalculated*, as regards the house, by the same person (one naturally suspects Māshā'allāh). Bearing in mind that all houses are given to degrees, one can say that they are well and consistently calculated according to what I am calling the *Standard* method, (1) or possible ($\hat{1}$). One might make occasional 'improvements' to the data recorded, but in only one case have I found it necessary to make a drastic alteration, and that where the wrong sign was listed.[174] The planetary data in the horoscopes were used by their editors to give 2 August 43 for the first and dates between 425 and 464 for the others. The horoscope 3·10 is from Rhetorius (Neugebauer and van Hoesen no. L.428), and is one we have already encountered as having been calculated according to method ($\hat{1}$). Rhetorius, however, has a different ascendent (and different houses) from Māshā'allāh, and he seems to have worked from Theon's tables for Clima V ($\phi = 40;56°$). If, furthermore, we revise all the data by assuming that method ($\hat{1}$) was used, we no longer obtain latitudes that are either plausible or consistent. The conclusion is that the author of the house-calculations was either Māshā'allāh or some one between his time and the fifth century.

Unfortunately, as soon as we have decided on this, we must at least reconsider the assumption of a Ptolemaic obliquity. To give an idea of the changes induced by a new parameter: when we take 23;30°, the mean latitude rises to 42;53°, but the standard deviation is greater.[175] Although it is perhaps unwise to put much reliance on figures derived from houses listed only to the nearest degree, it does after all seem likely that the tables used were somehow derived from the *Handy Tables*. Note there the table, for Byzantium, with $\phi = 43;35°$. Note also the possible bias introduced by rounding all figures down to the next lower degree. Our range of latitudes certainly looks much more likely to be Byzantine (say corresponding to present-day Bulgaria) than central Asian, and in any case to have been well outside Māshā'allāh's domain. These correctly calculated horoscopes are thus, as regards the house divisions, still in search of an author and a century.

Finally, note that although I have not quoted the ranges of uncertainty in the derived latitudes, because of their high level of consistency, they are not always insignificant.

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[172] Ibid., pp. 166, 174.

[173] With an obliquity of 23;51°, a longest day of $15^h\ 12^m$ corresponds to a latitude of 43;37°.

[174] For 'Pisces 4' read 'Aries 4' in the edition's drawing of horoscope 3.10 (see house 12).

[175] 50′ as against 38′.

Taking the worst case (ref. 3.8), and assuming rounding in either direction to the nearest degree, the range of uncertainty with ε = 23;51° is 37;54° to 42;21°. The horoscopes associated with Māshā'allāh's name would bear further investigation. I will mention one notorious example very briefly, that is to be found in printed European sources and in Latin manuscripts in Boston and Peterhouse, Cambridge. E. S. Kennedy noted the resemblances, but pointed out that although all three versions show the same ascendent (65°), upper mid-heaven is given differently (340° in the fourteenth-century Boston MS, 320° in the Nürnberg printing, and 302° in the fourteenth or early fifteenth century Peterhouse MS).[176] Without discussing ranges of possible obliquity, we can say categorically that the first manuscript suggests a latitude of about 21°, the printed version a latitude of a little over 25°, and the Peterhouse manuscript about 51°. The planetary material is for 23 May 791, and the horoscope, according to an associated text, was cast on behalf of someone asking whether or not he would receive a kingdom which had been promised to him. The date falls in the middle of the long reign of the caliph Hārūn ar-Rash̲īd, and, as Kennedy says, 'it is useless to speculate about the identity of the enquirer'. Perhaps it is not superfluous, however, to note that *none* of the derived latitudes is near Baghdād (33;20°), and that the latitudes of Medina and Mecca were commonly taken to be exactly 25° and 21° respectively. It is unwise to push the figure for mid-heaven too hard, but I note that in the strictest sense the Peterhouse figure is one degree higher than we should get with a Toledan obliquity taken with medieval a latitude of London (51;34°) or Oxford (51;50°). There is an odd, surely fortuitous, fact to be mentioned here. As D. J. Price pointed out, in commenting on the Peterhouse manuscript, John of Gaunt is an obvious candidate for an English subject of the right period who would desperately have liked a throne.[177] John was born in Ghent, at a latitude of about 51;04°, which happens to fit the Peterhouse data perfectly when taken with an obliquity of 23;33,30°. On the whole, though, it is wise to follow Kennedy's advice, and in any case to treat latitude derivations from integer cusp longitudes with great caution, except when they are considered statistically.

II.3. *Albohali, Zael, and Albumasar: some ninth-century survivals, and western embellishments*

Medieval western astrology was based, broadly speaking, on the writings of a dozen or so eastern writers, apart from the classical Greek authors who were known both directly and through them. I have already mentioned Abū ʿAlī al-Khayyāṭ, who died circa 835. Known in the West as Albohali (it would be impossible to list all the variants on the name), he wrote a work known as *De judiciis nativitatum* (under which title it appeared from the press of Johannes Heller, Nuremberg, 1540), translated into Latin first by Plato of Tivoli in 1136, and later by Johannes Hispalensis in 1153. In this section I shall consider briefly some horoscopes from his writings, at least as they were handed on in Latin, and others by Zael (Abū ʿUthmān Sahl ibn Bis̲h̲r, who flourished in Khurāsān in the first half of the ninth century)[178] and Albumasar (Abū Ma'shar, whom we have met already, and who flourished in Baghdad and died in 886). These three near contemporaries were all of the select band of highly influential authors, for different reasons. There is not much horoscopic material of importance in the Latin versions of their works, and what I have found I shall tabulate at the outset. It could clearly be multiplied very easily, since the number of known manuscripts of the works from which I am quoting runs into some scores, but I am here concerned mainly with general principles, for which the tabulated material will suffice.

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[176] Kennedy (1959). The associated text (of which only a part is given in the Peterhouse MS) is *De receptione*, a book on interrogations not extant in Arabic.

[177] Price (1955), Plate VIII (where the text is visible) and pp. 88–91 for transcription and comment. Price did not, of course, know the source of the horoscope or the associated text, nor did he appreciate the latitude implicit in it. In trying to date the horoscope, he settled tentatively on May 1379. Kennedy's note quite ruled out this dating, needless to say. It is interesting that Price did not associate this part of the MS with those he thought to have been penned by Chaucer.

[178] Brockelmann (1937), p. 396.

The first five examples (A to E in the table) are not in the strictest sense drawn horoscopes, at least not in the printed work from which I took them, *Albohali . . . de iudiciis nativitatum . . .*, published by Joachim Heller and printed by Joh. Montanus and Ulric Neuber in Nuremberg, 1549. There are four drawn figures in chapter xxxviii of the work, but without numerical data, seeming to imply that Abū ʿAlī al-Khayyāṭ used equal house divisions – but such an inference is dangerous, as we shall see. The data are here taken from the text (I have ignored only the positions of *pars fortune*), where they illustrate chapter vii, *De prosperitate et adversitate nati*. There are seven other examples, without numerical information, that is to say, having only the ascendent and the positions of the planets specified by the zodiacal sign. All twelve sets of information have been connected with the horoscopes of Māshā'allāh discussed in section II.2 above. It is shown in Appendix 3 of the work by Kennedy and Pingree that Māshā'allāh used an unknown sixth-century source, and that Abū ʿAlī borrowed in turn from him. The point to observe is that the data quoted by the two authors are – in the form of which it is extant – not in close agreement. (Only ten positions out of a maximum of forty-five are in precise agreement.) One could have deduced dates from the planetary material which would have allowed it to be matched with dates deduced from Māshā'allāh's horoscopes, but by indexing ascendents, or planetary positions, one would not have been led to the common element. The reason is presumably the corruption of the data, not necessarily without deliberation, somewhere along the line – for how else are we to explain the alteration of whole ascendent degrees into degrees and minutes? But since we know no data for mid-heaven, we cannot say why this was done. Perhaps the change took place in the West. (Taking C, with the original figure for mid-heaven, we deduce a latitude of 52°, but in other cases we get nonsensical results in this way.)

The dates deduced in Pingree and Kennedy are as follows (the numbers in brackets are their reference numbers, followed by the page reference):

A – 18.10.439 (3.8, p. 171),
B – 25.11.464 (3.9, . 171),
C – 8.09.428 (3.10, p. 172),
D – 7.02.442 (3.11, p. 173),
E – 16.04.455 (3.12, p. 174).

All are from the unknown sixth-century source, but C comes ultimately from Rhetorius, and we have met it before (section II.1, numbered L.428 by Neugebauer and van Hoesen).

The next four horoscopes in the table are associated with the name of Zael. As already indicated, this was the Latin apellation of Abū 'Uthmān Sahl, a Jewish astrologer and mathematician active in Khurāsān. He is said to have died between 822 and 850. (The horoscopes will help us to narrow down this range, as it turns out.) A copy of Zael's *Introductorium ad astrologiam seu de iudiciis* (inc. 'Signa in zodiaco sunt duodecim . . .') to be

	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Venus	Merc.	Moon	Caput	Style
A	—	—	—	211	—	—	45	201;12	168	188	—	221;15	146	38;40	—
B	—	—	—	76	—	—	345	232	259	249	223	231	16	293	—
C	—	—	—	51	—	—	254	197	171	167;17	137?	185	331	278	—
D	—	—	—	182;30	—	—	62	255	255	310	355	315	98;04	—	—
E	—	—	—	100;07	—	—	207	257	Sag.	24	—	—	197	227	—
F	104	131	160	191	224	255	—	105	—	—	—	—	—	—	(d)
G	331	9	46	80	102	138	66	350	—	—	123	87	165	—	(d)
H	334	8	45	72	103	124	66	350^s	38	102	123	87	160	352	(e)
J	Pis.	—	—	80	—	—	336^r	350^s	97	102	53	87	157	170	(d)
K	114;46	146;07	177	207;54	235;33	269	252	252	101;31	Hse 8	Hse 8	Hse 8	118	67	(f)
L	60;00	117;48	145;43	157;31	190	213;06	—	—	—	—	44;54	—	307	202;25	(f)
M	28;40	58;49	90;46	123;27	148;40	177;02	—	—	325;52	45	—	—	47	111;37	(f)
N	110	137	164	195	229	260	178;19	278;16	Leo	—	27;50?	16;25	Sco.	195;30	(e′)

Sources in brief
A to E – Albohali, *De iudiciis nativitatum*, pr. 1549.
F and G – Zael, *Introductorium ad astrologiam*, Bodleian Lib. MS Ashm. 369.
H – Zael, cited by Guido Bonatti, *Liber introductorius*, Bodleian Lib. MS Savile 15.
J – Aomar, *De iudiciis astrorum*, reporting Zael, MS Bodley 430.
K, L, M – Albumasar, *De magnis coniunctionibus*, British Lib. MS Harley 3631. There are similar data in MS Digby 114.
N – Albumasar, *De revolutionibus annorum mundi*, Bodleian Lib. MS Ashm. 369.

found in MS Ashmole 369, ff. 47r-, has several tiny figures drawn in the margin to style (d) of Fig. 1. Some of these are so sketchy as to be useless for any purpose, although they could perhaps be amplified with the help of the text. The two of value are at ff.49v (F in the table, concerning a king's rule) and 55v (G). As for H, this comes in the middle of a very fine (but late) copy of the astrological *summa* by Guido Bonatti in Bodleian MS Savile 15, ff. 229r–335v. No doubt other versions are extant; the important point is that the figure is said to be on a military question, and to come from Zael 'in libro iudiciorum' (f. 253r). The last Zael data are from a very untidy and incomplete figure in the *De iudiciis astrorum*, said to be by Aomar in MS Bodley 430, ff. 64r-(115v). It is usually supposed that the author was Abū Bakr ʿUmar Muḥammad ibn al-Farrukhān aṭ-Ṭabarī, who died around 815, having worked in Baghdad for al-Ma'mūn.[179] Since it includes the views of Zael, al-Kindī, and other later writers, its authorship is dubious, to say the least, but this is a point of small consequence for the horoscope J, at f. 68v. (Aomar has probably been confused with Alfraganus – compare 'al-Farghānī' and 'al-Farrukhān'.)

When we examine the four 'Zael' figures, we see at once that although G, H, and J diverge in many respects, they agree on too many points to have come from more than one source figure. They are too corrupt to be analysed easily – but we shall reconstitute the horoscope shortly. With F it is quite otherwise, and the simple exercise of transforming the longitudes of the cusps into right ascensions (the Standard method of division was clearly in use in all this material) yields such a well-tempered distribution of houses that it had certainly not travelled the same circuitous route as the material that produced G, H, and J. In fact when we use it to derive a latitude, this turns out to be in the neighbourhood of 49;20°. Although with several degrees of uncertainty, the latitude is likely to be central European. (With the assumptions of the end of section I.7 above, the range will be either 46.2° to 52.2° or 45.4° to 53.1°.) It seems probable that the horoscope had a connection with Nuremberg, the town of printing.

The procedure to be adopted in analysing G, H, and J, is to convert all cusp longitudes to right ascensions (the obliquity adopted is not critical) and to choose between textual variants so as to best equalize the houses. We finish with a sequence of readings 331/9/46/80/103/124, thus drawing support from all three versions. (126 would have been preferable to 124.) Whether using the obliquity of 23;51° or 23;35°, or of course anything between the two, we derive a latitude of between 32° and 33° – I will not quote for the range of uncertainty. These are strongly suggestive of both Khur and Baghdad.

More interesting still is the date we derive from the planetary positions. Again J is of least help – but now it falls in line with G and H more often. We have a very good fit on 30 June 824 A.D., and if we choose to have the Moon in a better position, sacrificing some of the accuracy then, we shall take 4 July of the same year. On the former date, the planetary longitudes were, to the nearest degree, and in the same sequence as our table, 70/354/38/102/133/85/103. The derived date must surely be taken to add a trifle of biographical information to what is known of Abū ʿUthmān Sahl, namely that he was still alive after the first terminus quoted by Brockelman (207A.H./822 A.D.).

The Albumasar figures, finally, are deceptive in their implied accuracy (implied, that is, by their being usually given to minutes of arc). The first three (K, L, and M) are taken from a thirteenth-century copy of Abū Maʿshar's *De magnis coniunctionibus* in British Library MS Harley 3631. Whereas roman numerals had been used earlier in the codex for the *Introductorium maius* by the same author, arabic numerals are used in the three horoscopes that come, painstakingly drawn, at f.108 r & v. As with the Zael example, so these are done on the Standard system, but the accuracy of the material is so poor that the scribe has added a marginal note ending 'et etiam scias figuras fore coruptas'! Perhaps he knew that he could not do justice to the roman numerals he was copying. I am inclined to make the following alterations to the cusp longitudes in the table:

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[179] Carmody (1956), pp. 39–40, notes only one MS, and not this, which begins 'Quoniam astronomie totius fructus . . .' (slightly different from his quoted incipit). One might also refer to a 13th-cent. copy of a text beginning 'Astronomie iudiciorum fructus . . .' in MS Bodley 430, ff. 51v–64v, to which a 14th-cent. glossator has added with a stylus – partly inked in – six horoscopes in style (d) of Fig. 1, the houses there being indicated only to zodiacal signs (ff. 60v–61r).

K: 179;30° or near, for 177°, 212;54° for 207;54°, 242;33° for 235;33°. (These are not all ideal, but could be explained in terms of misreadings of roman numerals.) The derived longitude is 16;35° with the Ptolemaic obliquity – close to the Ptolemaic 16;27° for the first climate. Other values for ε give less satisfactory agreement with the latitude of the climate on their own scales.

L: 88;48° for 117;48°, 122;43° for 145;43°, 156;31° for 157;31°, and 185° for 190°. This is very uncertain. The derived latitude is 48;39° (Ptolemaic obl.) – cf. the seventh climate, 48;32°.

M: 23;40° for 28;40° and possibly 90;26° for 90;46°. The derived latitude (Ptolemaic obl.) is 33;59° – cf. the commonly quoted 33;25° for Baghdad, where Abū Maʿshar began his career.

The planetary positions in the horoscope K, the only example of much value, do not all agree with the actual state of the heavens, on 3 October 809, but the three slowest planets fit that date well. The conjunction took place at 243.1°, with Mars at about 99°. The Moon was at 118° about two days later, and this could have been the date intended. The Sun, on 3 October, was in the twelfth house of the figure in the manuscript, and Venus and Mercury were in the first. There were other great conjunctions of Saturn and Jupiter in 868 and 928, at roughly the same place in the ecliptic, but they are by no means as suited to the given data as that of 809. The *Book of Conjunctions* seems, even so, to have been written after the conjunction of 868, and a prediction is made in it of events in Basra for the fifteen years following the sixtieth year after the 809 conjunction.[180] It was translated by John of Seville, and printed in due course by Erhard Ratdolt at Augsburg in 1489, but the printed edition does not include any horoscopes. The copy in MS Digby 114 contains versions of K, L, and M.

The three horoscopes K, L, and M, seen in their western context, reveal what seems to me to be an interesting expectation, namely, *that every house will be in a different sign of the zodiac*. If we look at K, we see that this is there the case, and legitimately so. As presented, it is so in L, except that when the writer (whoever that ultimately was) reached the eighth house he used a form of words that he was to use on four occasions in M: 'octavus Aries et eius gradus in Tauro 2 gr. 32 min.' This makes no sense at all, from the point of view of the geometrically divided, 'mundane', houses, but seems to relate to the expectations of one who is confusing two different systems – the Standard method of division on the one hand and the zodiacal planetary domiciles, or the simple 30° house system, on the other.

The last of the Albumasar horoscopes, namely N in the table, is taken from another John of Seville translation, this time of the 'Book of revolutions of world-years', the *De*

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[180] DSB art. by Pingree, vol. 1, p. 36.

revolutionibus annorum mundi, for which I have used the Bodleian MS Ashmole 369 (ff. 103r-33v; this was included in the Ratdolt edition of the former work, on conjunctions). The text is in a late twelfth- or early thirteenth-century hand. The figure comes at f. 120, and while the text has roman numerals, the figure has been filled in at a somewhat later date in arabic numerals, based on the text, but inexpertly. The data in the table are from the text, where there is a reference to ascensions *at Toledo* (quoting a date equivalent to 20 March 656). The planets are a moderately good fit for that date, without exception (they were at approx. 175/280/156/3/30/5/232, in the sequence of the table). The date intended, however, was fairly certainly 19 March, when the Sun was judged to enter Aries, and when according to the *Fī qiyām al-khulafā'* of Māshā'allāh, who gave a very rudimentary horoscope for the event, ʿAlī ibn Abī Ṭālib acceded to the caliphate.[181] As for the houses, however, they are almost certainly not connected with this historical event, or indeed with the text; and it seems just as unlikely that John of Seville was responsible for them – assuming that he never left Iberian latitudes. I suspect that the cusps were inserted by an English copyist or reader. The argument for this conclusion is basd on the following analysis of the houses in N.

The cusp longitudes (houses 10 to 4), with the corresponding right ascensions on the line below (using the obliquity of 23;33,30°, but this is not critical), and the differences between these (i.e. the house sizes) are:

λ_{10}		λ_{11}		λ_{12}		λ_1		λ_2		λ_3		λ_4
110		137		164		195		229		260		290
111.66		139.48		165.27		193.80		226.52		259.11		291.66
	27.82		25.80		28.53		32.72		32.59		32.54	

If we change the reading of 164 to 165, there is an improvement in the day houses, so that the total complement now reads:

27.82 26.72 27.60 32.72 32.59 32.54

This is as much as one could wish for, with integer degrees in the original horoscope. Suppose now that we accept the glossator's habit of rounding both up and down to the next degree, that is, by more than half a degree. The two ranges of uncertainty of the sort discussed at the end of section I.7, with the notation there introduced, will be:

from (194,110) to (196,110), that is from 57.5° to 47.4°,
and
from (195,109) to (195,111), that is, from 48.7° to 56.2°.

This argument brings us securely into northern Europe, and fairly certainly into England, where the copy was made.

If this argument is acceptable, then we have here a *composite* horoscope, with the planets inserted on the basis of the text, and the houses on the basis of a local situation. This does not mean that they were entirely original, and as it happens, in this case, we may be reasonably sure that they are not. The reason is that Guido Bonatti's *Liber astronomicus* has a similar version,[182] but one from which the cusp longitudes in the English copy seem to have been systematically changed. Whether or not this is so, the cusps quoted by Guido (107/135/164/195/228/258) suggest, if they are not corrupt, a latitude of about 38° – within a degree of Seville. They are presumably close to data supplied by John of Seville – and again not original. Both versions, then, like the material in Albohali, are authentic originals with accretions to provide local colour. Like the first from the printed Zael, they carry with them the clues to their interpolated character. On the planetary side, however, it seems that Abū Maʿshar might have played the same borrowing game: we recall that his other examples contain more or less contemporaneous events, as did the Zael figure that surfaces in three different versions, G, H, and J.

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[181] Kennedy and Pingree (1971), p. 131, for the translated text, which simply puts Saturn in Virgo, Jupiter in Capricorn, and Mars in Leo. The books by Abū Maʿshar, on the revolutions of the world-years, explains how the character of a year is to be assessed on the strength of the horoscope of its first moment, i.e. when the Sun enters Aries.

The date is given in a peculiarly inverted way in the MS: 'in .viii.x. die . . . ramadar', that is, the eighteenth day, the year being 35 A.H.

[182] See Bodleian MS Savile 15, f. 328vb, for Guido's rendering.

II.4. *Alchabitius'* Introductorius *and some alien material*

Western manuscripts often attach the name of Alchabitius to texts and fragments of texts without any clear justification, and since at least a part of the textual problem is to separate the horoscopes that might plausibly be ascribed to him from those that are clearly not his, I will examine some examples here. Alchabitius, sometimes called Abdaylaziz (to adopt one of a dozen spellings), was the name adopted in the West for Abū al-Ṣaqr ʿAbd al-ʿAzīz ibn ʿU͟thmān ibn ʿAlī al-Qabīṣī, a scholar who flourished in the mid-tenth century in Aleppo. He came from Mosul, or possibly Sāmarra, both in present-day Iraq. His principle surviving work was translated into Latin by John of Seville in 1144, and later into French (perhaps from the Latin) by Pélerin de Prusse in 1362. John of Saxony wrote a commentary on this work in 1331, or thereabouts, as Cecco d'Ascoli (1269–1327) had done, and as Valentin Nabod was to do in the sixteenth century.[183] Generally known as the *Liber introductorius*, John of Seville's version of the work by al-Qabīṣī begins 'Postulata a domino prolixitate vite . . .', and since this is the incipit of the commentary section of John of Saxony's work, the two items are often confused in library catalogues – an old problem with commentaries, of course. (The text of the commentary as a whole begins 'Vir sapiens dominabitur astris . . .'.)

The copy of the text to be considered here, without prejudice as to its purity, is that in the Bodleian MS Digby 48, which we have found to depend for other material on the Ratdolt printing of Abraham Judaeus. For the Alchabitius text this does *not* seem to be a problem – they have a solitary drawn horoscope in common, and that with several variant readings. This is from the commentary, a fact that is not immediately obvious, and is horoscope G in the following table. The others come only from the Digby version of John of Saxony's commentary.

Although the first of these horoscopes, that from the *Introductorius*, does not give the precise degree of every house, there is enough information to derive an approximate latitude, and to correct the reading of λ_2, on the assumption that the calculation was Standard. (For 327° read 322°.) The ascendent is confirmed by the stated place of the lot of fortune (137° – see section II.21). The text confirms that mid-heaven was 218°. There is a good copy of the same text in MS Ashmole 369, at ff. 21r–32v, of a much earlier period – perhaps even of the end of the twelfth century. Here the figure is drawn to style (d) still, but the ascendent is wrongly given as 277°. The planetary information in A is not enough to date it, but the latitude strongly suggests that the figures for λ_1 and λ_{10} are authentic,

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[183] See sections I.15 above and II.13 below. For an authoritative account of al-Qabīṣī, consult the art. by D. Pingree in the *Encyclopedia of Islam*.

	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon	Caput	ϕ	
A	218	Sco.	Sag.	287	327	Pis.				345			195		35.5°	A
B	156	180	204	227	262	297	156	250							52.29	B
C	10	31	51	70	107	147		250							51.67	C
D	140	165	191	217	252	285	156								50.97	D
E	157	181	205	228	264	299		250							51.74	E
F	100	127	157	188	221	251	154								48.00	F
G	38	72	106	140[a]	168	191	142;37[b]	213;37[c]	20;54[d]	64;46[e]	48;42	88;11[f]	63;06[g]		47.43	G
H	200	220	240	260	297	337	154	224	107	197	217	189;17	66	259	48.85	H
J	96	123	153	185	217	248	170								(44.40)	J
K	305	347	30	70	88	106							305		51.78	K
L	245	266	284	305	344	26							305		51.34	L
M	290	327	7	47	69	89	156						305		51.80	M
N	329	13	53	91	109	129	149			356;43					48.86	N
O	96	124	153	185	217	246			105;03						(44.40)	O

Dates derived:
G – 17.05.1389
H – 01.10.1389
J – 06.02.1391
N – 09.03.1331
O – 12.03.1331

Variant readings as between MS Digby 48 and the printed edition (1485): a – 200; b – 138; c – 213;27; d – 28;14; e – 34;26; f – 58;11; g – 33;06. The positions of the Sun, Moon, and Mars are not consistent, and the date offered is derived by arbitrarily taking the Sun's position as 64;46°.

although we cannot rule out the possibility that some later astronomer has calculated the value quoted for λ_2. Indeed, if we take that last value, find the corresponding right ascension, and deduce the implied value of the right ascension of mid-heaven, using this to derive in turn a latitude, we find 52.31° (as always an ideal figure). This is so strongly reminiscent of the figures obtained from at least seven of the horoscopes on our list, that we are probably safe in dismissing horoscope A as a fabrication, albeit based on two longitudes quoted in the text of al-Qabīṣī.

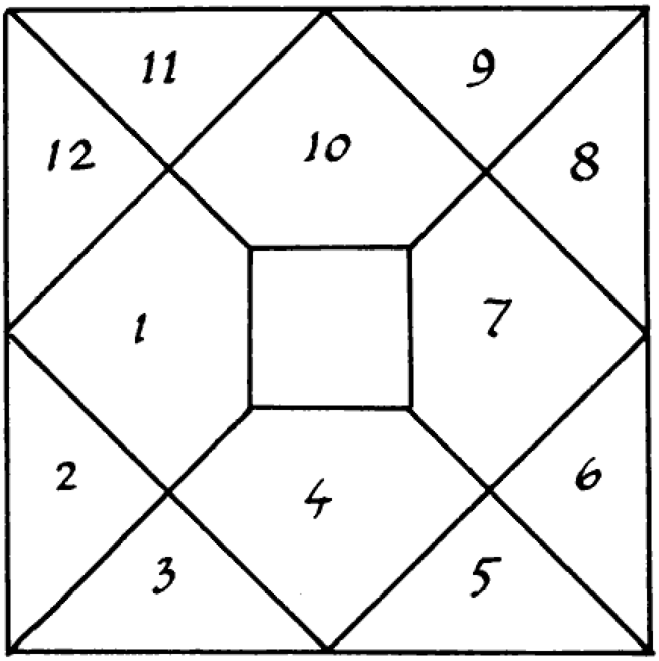

Fig. 20 A not uncommon variant (e′) of the very common style (e) of Fig. 1.

The horoscopes in the John of Saxony commentary come in the Digby manuscript between ff. 254r and 302v, are mostly small and marginal, and to style (e′), Fig. 20. In the first printed edition[184] there is only *one* drawn figure – that for G, variants apart – while the others are recorded only in text form. We can say at once that *none* seems to derive in a strong sense from al-Qabīṣī, as the latitudes alone show. These latitudes are puzzling, as are the few dates that we may derive (G, H) or find within the text itself (N, O, and perhaps J). J is here dated on the strength of a brief reference to a nativity at Paris, on 6 February 1391, a reference in a footnote on the previous page (in the Digby MS), and the face that the position of Saturn (the only planet in J) is within half a degree of the true position on the date in question. Note the similarities between the houses in J and O – the latter for 1331. O is for the entry of the Sun into Aries (something we shall encounter on a number of other occasions), while N is for the preceding conjunction of the Sun and Moon. (See section II.19 for the first custom and I.19 and II.21 for the second.) But how then are we to explain the wide separation of dates? John of Saxony was quite certainly dead by the 1380s – in fact he seems to have been born more than a century before. The derived latitudes are puzzling because they seem to fall into two distinct groups, the first of FGHJNO and the second of BCDEKLM. It is conceivable that this grouping is an illusion, but there are some reasons for thinking that this is not so. First, we note that all the Paris links (and dates) are with the first group. Second, consider B, as a specimen of the second group. The range of uncertainty in ϕ, allowing that mid-heaven may vary by a degree from 227°, with the ascendent fixed, is from 50.64° to 53.88°, while reversing roles the range is 51.20° to 53.32°. This suggests that whatever tables were used for the second group, they were not Paris tables. If we divide the examples into two groups, drop J and O (which are classic cases of the failure of our method in the neighbourhood of $\lambda_1 = 180°$), and take the arithmetic means, we find values for ϕ of 48;17° and 51;40° respectively – and of course Paris suggests itself clearly in the first case, and London or Oxford in the second.

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[184] The main text was issued at Mantua by Johannes Vurster in 1473, and again by Erhard Ratdolt from Venice in 1482 and 1485, but the commentary did not appear until 1485, and thereafter: *Liber Ysagogicus Abdilazi, id est servi gloriosi Dei: qui dicitur Alchabitius ad Magisterium iuditiorum astrorum* . . . The commentary is set in a different typeface. The colophon says it was finished at Paris in 1331 and corrected by Dom. Bartholomeus de Alten de Nusia.

For reference, the substitute line in the table (horoscope G) is as follows:
38/72/106/200/228/191//138/213;27/28;14/4;26/48;42/88; 11/63;06.

This is not to exclude the possibility of other (continental) locations for the second group. It is conceivable, for instance, that the group is somehow connected with John of Saxony's home territory, and that the material is extant in his writings, in which case the hypothesis of a part-English connection must be abandoned. There is, though, another strange fact to be mentioned. The Bodleian manuscript Laud. misc. 674 contains much material by, and in the hand of, William of Worcester. Our Appendix II, in fact, includes a list of towns, with their longitudes and latitudes, taken from that codex. Another item to be found there is a set of canons for the tables of John Walter (ff. 20(e)v to 24v), and at the end of this there is an example of domification using the tables, their author being mentioned in the third person. The explicit runs as folows:

> Expliciunt canones tabularum Walteri socii collegii Wyncestrie quondam Oxonie, scripti Bristow [Bristol] per manus Willelmi Worcestre anno Christi 1438 22 die mensis Aprilis. (23v)

The six longitudes from the horoscope are:

λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
155;29	179;00	204;40	227;40	263;01	297;00

and there is an indication in the central square that Jupiter is ascending (with the first house) and at a longitude of 246;25°. The writer seems to have tampered, none too successfully, with Oxonian house divisions, while on the day named, Jupiter was at a longitude of around 263°, so neither can that part of the calculation have been very well performed. The statement concerning Jupiter was obviously not casual, nor was the setting of the scheme so – for the Sun had just set. What is striking, though, is the resemblance between this horoscope and E, in the table above. Perhaps the group whose members we have singled out as possibly English, three of them with the same Jupiter position, is somehow connected with William of Worcester, or perhaps the resemblances arise only by chance.

II.5. *Haly ibn Ridwan and Haly ibn 'Ragel. Further interpolations in standard authorities*

To the classic eastern writers introduced in the last three sections, writers who so greatly influenced medieval western astrology, two more names must be added. They are often confused by virtue of the fact that both were often shortened to 'Haly'. Abū'l-Ḥasan ᶜAlī ibn 'Alī ibn Ja'far al-Miṣrī ibn Riḍwān wrote primarily on medicine and astrology. Said to have been born in El Gizāh, close to Cairo, in A.D. 988 (but see below), he died in Cairo in

1061 or 1069. Abū'l-Ḥasan ᶜAlī ibn Abī'r Rijāl ash-Shaybānī al-Kātib al-Maghribī was born in Spain or North Africa, flourished in Tunis in the third and fourth decades of the eleventh century, and seems to have died after 1040. He is known in the West by such names as Abenragel and Albohacen, in addition to that used above, while ᶜAlī ibn Riḍwān is occasionally distinguished as Haly Abenrudian.[185]

Ibn Riḍwān wrote a work that could be regarded as a commentary on Ptolemy's *Tetrabiblos*, and that was translated by Aegidius de Tebaldis of Parma under the patronage of Alfonso X of Castile in the latter half of the thirteenth century (incipit 'Scire et intelligere gloriosum est quia omnis . . .'). Helped by Petrus de Regio, the same translator turned into Latin a Castilian version of the astrological treatise *Kitāb al-bāri' fī aḥkām an-nujūm* by the other Haly, which has added to the confusion of names in some places. This other translation was often printed, beginning with Erhard Ratdolt's edition of 1485, Venice: *Liber in iudiciis astrorum*, ed. Bartholomaeus de Alten. (The author here goes under the name of Haly filius Abenragel.)

Of the two sets of horoscopes associated in the West with these Muslim astrologers, that to be found with the commentary on Ptolemy is, it seems, original to the work in question, whereas the writings of the later, Maghribi, astrologer seem to have acquired a patina of horoscopic material unconnected with his time and circumstances. This is not to say that the nature of the horoscopes added to ibn Riḍwān's commentary was always well understood. The first of them, for instance, in MS Ashmole 369, is described as 'figura nativitatis *Ptholomei*', for reasons that are easily understood. The version in MS Bodley 597 is earlier and is better placed in context, and the following details of three horoscopes (to be found in both manuscripts, and elsewhere) are taken primarily from it, with variants reported briefly from the Ashmole manuscript. As for MS Bodley 597, the commentary lies bewen ff. 1r and 102v, is in a fourteenth- or fifteenth-century hand, and ends 'Explicit Kaylle quadripartitus Tholomei cum commento Aly'. The first name is perhaps that of Henry Kayle (to adopt the spelling used by A. B. Emden), Fellow successively of Exeter and Oriel colleges, Oxford, who died in 1422 in his mid-thirties.[186] The main work seems to end at f. 100r, but there follows a long postscript, containing the horoscopes, and beginning.

> Volo in hoc loco dare tibi exemplum nativitatum ut melius intendas quicquam locuti sumus in eis et prima est nativitas mea. Ego natus fui in 3° climate in loco in quo divisit Tholomeus terram Egipti in duabus partibus quando locutus fuit de figura terre et est latitudo illius loci 30 grad., et fuit in 356 annis here Gezdargit, et anguli et loca planetarum erant eadem horam sicut in figura predicta.

His own horoscope, therefore, is the first of the three, namely A in the table on page 86. There are very many possible interpretations of the data in the three horoscopes, due to the usual ambiguities of sign, but two of the three may be very accurately dated, if I am not mistaken, at the morning of 15 January 988 A.D. (horoscope A) and the morning of 17 September 1007 (horoscope C). A rather poor fit may be found for B, within the lifetime of the author, on 30 May 1029, or thereabouts, but the uncertainty of zodiacal sign makes this problematical. For comparison with the table, the three dates offered give planetary

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[185] On Ibn Ragel see Fuat Sezgin, *Geschichte des Arabischen Schrifttums*, vii (Leiden, 1979), pp. 186–8. On Ibn Riḍwān see *Encyclopedia of Islam*, iii (Leiden and London, 1971), pp. 906–7.

[186] The only other man of this surname in Emden (1957–9) lived a century later. I have added the final 'e' to represent a long final flourish in the 'Kayll' of the MS. Kaylle was presumably only claiming to have copied out the work.

		λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon	Caput
A	100r	270;28	299;21	329;11	0;31	32;17	62;11	269;13	298;18	299;48	300;32	264;24	312;19	213;15	259;51
B	101r	177;19	204;46	230;46	254;11	286;48	309;48	Hse 6	88;14	11;33	14	Hse 6	48	35;36	42(?)
C	101v	112;35	149;19	171;21	201;51	238	268;40	161	151;08	154;40	179;48	161	170	211;44	237;45

Notes and variants (MS Ashmole 369 is denoted by a*)
Horoscope A: MS note on λ_1: elevaciones eius 0.15 (i.e. 0;15° right ascension). Value poor. MS a* has 0;25°, but 0;37° for λ_1. Mercury and Moon have latitudes assigned, both meridional, respectively 2;28° and 3;56°. MS a* has Mercury longitude as 312;19,10°. MS Bodley has Cauda Draconis at 77;51°. MS a* has Caput at 77;05°. MSS give positions for Alhabor (on merid. circle) and the Lot of Fortune.
Horoscope B: MS a* has Jupiter at 118;14°, Mars at 341;33°, Sun at 344°, Venus in Tauro, Moon at 36° and λ_2 at 285;48°. Both MSS have an error in λ_3, which should obviously be 319;31° (as may be accurately verified).
Horoscope C: There are ambiguities in the signs of the three superior planets especially. Another copy in MS Digby 179, f. 169v, agrees with all the signs chosen here except for Caput Draconis (207;45°). Only one reading is there different, namely 159;11° for Venus.

longitudes as follows: A(270/270/323/300/264/318/213), B(55/88/16/74/28/52/256), and C(158/154/155/179/190/204/212). It will be clear from a comparison that a number of positions in the table have been assigned to the wrong sign, and nothing has been done to correct such mistakes (see Jupiter and Mars in A, Venus and Mercury in C, for example).

One thing that emerges very clearly, through the mist of poor textual transmission, is the high degree of accuracy in the original computation, especially on the astrologer's own nativity. He has calculated not only longitudes but latitudes – a sure sign of an expert in these matters. He invariably gives the Lot of Fortune, and this allows us to test for consistency in the positions of Sun, Moon, and ascendent (see p. 146 below for the method). There is good (if not exact) agreement for A and C. For B the Lot of Fortune is given as 275;05°, which agrees well enough with the table (35;36° – 14;00° + 254;11° = 275;47°), and so militates against my emendation of the Sun's longitude (74° for 14°). The difference could still be explained easily enough – for example in terms of a later addition of the Lot of Fortune.

As we have seen, ᶜAlī ibn Riḍwān has told us his latitude – which is just as well, for his own horoscope is one where the ascendent is very close to 0°. He has used Ptolemy's tables for the third climate, latitude 30;22° – very near to the traditional 30° for Cairo. In fact his birthplace, al-Jīza (Giza), is on the thirtieth parallel. When we apply our usual analysis to B and C, we find that like A, B is well calculated on the Standard method, now yielding a latitude of 31;06° with the Ptolemaic obliquity. It was obviously drawn up using the same tables, that is, for the third climate. No doubt C was done by the same method, but it is very corrupt (or incompetent), and the derived latitude of 26;18° should be treated with caution. It is too corrupt to be restored with confidence, but the text informs us that the nativity it represents was 'in insula Afforcat civitate Egipi (*sic*), et ego probavi'. On the second nativity, namely B, the astrologer tells us that it was in large part proved by him, and that it was for the city of Alfozzat in Egypt. I take it that the two places in question were a part of what we now call Cairo.[187] Al-Fusṭāṭ was in fact founded by ʿAmr, Egypt's conqueror in A.D. 641, and was the most important part of the metropolis until overshadowed by Jawhar al-Qāid's new capital (al-Qāhira), founded in A.D. 968.

One of the consequences of our findings is that the traditional date of birth for ᶜAlī ibn Riḍwān is in need of revision. The date derived for A is in keeping with the Yazdijird date of 356, quoted in the preamble to the relevant part of the text. It seems quite conclusive that he was born on 15 January A.D. 988, or 27 Dei 356 in the Yazdijird era.

Finally, it is worth noticing how Cardan was later to mangle horoscopes A and C, the first appearing as for 'Hali Rodoan' and dated 'Iedazert 356', the other being for a 'socius Hali', and qualified 'tempus deest'![188] Since, as we shall see, Cardan adopted the method of equal ecliptic divisions for the houses, our method (6), it is not surprising that he sets the cusp longitudes at 0;37°, 30;37°, . . . etc., in the case of A, and 201;15°, 231;15°, . . . etc., in the case of C. He starts, of course, from the ascendent – and adopts, as it happens, the Ashmole 369 reading for A. Whether or not he seriously believed that he was improving on the original, it is hard to say. As for the other reading, I suspect that it is true to the original, since an ascendent of 201;15°, taken together with mid-heaven at 112;35° and a Ptolemaic obliquity, implies a latitude of 29;50°. The horoscope could be reconstituted quite reasonably, taking the cusp longitudes as 112;35/140;19/170;21/201;15/234/263;40. There are too many uncertainties for us to be at all confident of this, however.

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[187] I learn from Mrs Mary-Helen Kennedy that she finds the origin of these names in the Latin *fossatum*, which is close to *fozzat* (giving rise in turn to *forcat* by an obvious scribal route; and Prof. Edward Kennedy has pointed out to me that ʿAli was born on an *island* (namely Gīza).

[188] Cardan (1543), items 15 and 26.

Before considering the work of the second Haly, I will give an example of a likely confusion of the two. In an anonymous Latin treatise on comets, evidently written around 1238, there is information that has the makings of a horoscope, although we are given only the ascendent, mid-heaven, and the planetary positions at the time of sighting of a certain comet, said to have been reported by Haly Abenragel. These are as follows, the lower line containing information said to have been taken from Haly ben Rodoan, and to be found in A. G. Pingré's *Cométographie.*[189]

λ_{10}	λ_1	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon	Caput
28;37	124;02	132;02	93;21	231;10	33;00	72;28	35;51	33;00	231;19
—	—	132;11	101;21	231;09	45;00	72;28	35;58	45;00	—

The comet is put in 3° or 4° Scorpio (Pingré: 15° of the same sign), and we are clearly dealing with the same comet, the information having been garbled in the process of transmission. Since the comet is said to have been 'super Afortas civitate Egipti', this is presumably the Egyptian Haly's information, and Pingré is to be preferred to the 1238 treatise (at least as copied, and edited). Pingré's planetary data are also to be preferred, and from them it is a straightforward matter to derive a date of 30 April 1006 A.D. (Pingré has 22 March 1006). Note that with the date offered above for his birth, ᶜAlī ibn Riḍwān would have been eighteen at the time of the comet, whereas ᶜAlī ibn Rijāl was not yet born in 1006. Since the comet treatise has such poor readings for the planetary longitudes, perhaps it is unwise to derive a geographical latitude from λ_1 and λ_{10}; but for the record, this comes out at about 25;51° (the obliquity makes little difference). The comet treatise, incidentally, gives useful testimony to the writer's acceptance of the Standard method of house division, but he does not avail himself of it in the work in question.[190]

Although there are perhaps more than a dozen manuscript tracts in Latin purporting to be by Haly Abenragel, most if not all of them derive from the work already mentioned, for which I take the title of the first printed edition, *In iudiciis astrorum*. Of the three copies of this that I have consulted, the Ratdolt *princeps* edition is lacking in horoscope diagrams, as is the otherwise interesting copy in MS Corpus Christi College, Oxford, (D)151. The latter is a work that Peter of Beccles, an Oxford Carmelite, commissioned to be copied in Oxford in 1380. It was later presented by John Holbrook to his college, Peterhouse, Cambridge (1426).[191] Another copy of this much excerpted and much quoted treatise is to be found as the first item in a magnificent fifteenth-century codex, now Bodleian MS Savile 15.[192] This opens with a figure, which is explained in these words:

> Hec est figura inicii translacionis huius libri die Jovis mensis Marcii 21 die Moharan era Arabum 652, Christi 1253, Cesaris 1291, Alexandri 1565.

The beginning of the translation, and the horoscope in question, are thus very precisely dated. The details of the latter are to be found in the following table (item A), and from

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[189] Thorndike (1950), pp. 60–1 and 15.

[190] 'Et quando tu sciveris quot sunt hore inter planetam et nonam domum, manifestum est quod inter ascendentem et decimam sunt sex hore temporales.' Ibid., p. 48.

[191] For further information as to Holbrook's interest in these matters, see sections II.17 and II.21 below. Note that *In iudiciis astrorum* fills the entire Corpus Christi Coll. MS, of 219 fols.

[192] Inc.: 'Dixit Haly filius Abenragel . . .'. The catalogue (*Summary Cat.*, no. 6561) states that the MS, which is in large folio and in a 15th-cent. binding, belonged to the Franciscans of Doncaster, but the late N. Ker rejected the idea. It did belong to John Dee.

	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon	Caput
A	274;18	303;08	334;35	8	38;51	67;21	286	65;37	132	(358)	32	13;30	249	$148;22^a$
	(cf. longitudes planets, 12.03.1254)						289	65	133	359	32	15	249	
B	72	103	133	166	197	225	299	229^b	21	336	339^c	349^c	23	
	(cf. longitudes planets, 15.02.1402)						296	248	21	335	301	320	126	
C	292	332	314	54	73	93	233;42	34;30	282	289	$301;13^c$	291;10	$136;40^b$	
	(cf. longitudes planets, 1.01.1396)						230	51	297	289	280	302	171	
D	Sco.	265	285	305	Pis.	Ari.	262	149	201	135	165	123^b	109	
	(cf. longitudes planets, 30.07.1399)						260	161	218	135	160	152	100	

Notes: a. Ambiguous. Could be read as 328;22°
b. Should perhaps be increased by a sign.
c. Should perhaps be decreased by a sign.

them we can say that the year should have been put at 1254 in the Christian era, and the apparent time about 6.25 a.m. on 12 March. The day in the Islamic calendar is 20 Muḥarram. The use of the Spanish era (Caesaris 1291) is not surprising, in view of Aegidius de Tebaldis's connection with Alfonso, and 1291 in that reckoning corresponds with the mistaken 1253 A.D., showing that the basic calculation was done in the Islamic calendar.

The houses given for this horoscope celebrating the commencement of the translation are well calculated on the Standard plan, and no drastic emendation is needed. From them we derive a geographical latitude of 39;42°, assuming an obliquity of 23;33,30° – which shows fairly conclusively that, whatever the combination of parameters used in the relevant tables of ascensions, the tables for the town of Toledo were in use. (See the analysis of them in section I.4.) In the tables of geographical coordinates associated with the Toledan corpus, Toledo is given as at latitude 40;00°, but in the canons, and tables of type T_2, the stated latitude of the place is 39;54°.

There are three other horoscopes in the Aegidius translation in MS Savile 15, namely B, C, and D in the table. These are not at all in the same class of accurately computed material as A. Betwen A.D. 1000 and 1500, there are no years during which the planetary positions were well fitted to those in the horoscopes, but there are three years when the fit is best, and it so happens that these form a cluster (1396, 1399, 1402), from which I conclude that they were the intended years. The approximate planetary positions (to the nearest degree in each case, for the times indicated by the orientation of the houses – see section I.18) are shown in the table. The time of day only presents a significant problem in relation to the fast moving Moon.

The longitudes of the cusps of the houses indicate English latitudes, which is what we should expect from the lateness of the dates together with an English provenance. The derivation of latitudes is not by any means straightforward. From B we get a figure in the neighbourhood of 50°, but then we find, on checking the data for well equalized houses, that the key value of λ_{10} is best replaced by a higher figure (74° for 72°), leading to a latitude in the neighbourhood of 39°. The very figures that are used in the horoscope, however, are to be found in the table of houses for the latitude of Oxford, compiled by Nicholas of Lynn a few years before the date of the horoscope. (For more details of these tables, see section II.18 below.) Despite appearances, therefore, we may consider this an English horoscope, in view of what we find for the other two. In the case of C we should derive a latitude in excess of 60° if we were not to make corrections to it, to equalize the houses in right ascension. The corrections are small, and easily explained as copying errors (293° for 292°, 14° for 314°). Having made the changes, we derive a latitude of 52;48°. Horoscope D is more problematical, but we may reconstruct it on the basis of houses 11, 12 and 1. In the first line below we have the longitudes of the cusps, as given to us. In the second line are the corresponding right ascensions (with obliquity 23;33,30°), those in parentheses being obtained by extrapolation. The mean size of a rising (eastern) day house in right ascension is taken as 21.42°, differing from 60° by 38.58°, the size of a rising night house. The last line gives the longitudes corresponding to these right ascensions, to the nearest degree:

Sco.	265	285	305	Pis.	Aries
(243.13)	264.55	286.29	307.38	(345.96)	(24.55)
245	265	285	305	345	26

The latitude derived from λ_1 and λ_{10} is 51;26°, a figure that is of course subject to uncertainties through rounding in the original. It seems, in conclusion, that we are justified in treating the latitudes for which B, C, and D, were drawn up as English latitudes, although we cannot be more precise. At all events, the general level of calculation evident in B, C, and D is not high.

Whether these English interpolated horoscopes are a sign of more extensive tampering with the translated text, is something for a future editor to decide. There is a similar possibility, as we have already seen, in the Alchabitius treatise discussed in the last section, and we shall encounter a number of comparable instances in later sections.

This is not unusual: there was considerable Muslim activity along the same lines. Professor E. S. Kennedy has drawn my attention to large numbers of horoscope books written in Persian, in which a court astrologer will cast the anniversary of his patron's birth for a reasonably expected life and in which interpolations are found.

II.6. *Double horoscopes – examples from the Cairo Geniza*

In editing a number of horoscopes, largely from the eleventh and twelfth centuries, from the Cairo Geniza, B. R. Goldstein and David Pingree have given evidence not only that the practice of astrology was influential within the Jewish community of Cairo, but that *anniversary horoscopes* were long in vogue there.[193]

In the first example, provided by Goldstein and Pingree, A(1977),[194] the subject was born on 17 June 1066, and the anniversary was 17 June 1082, when the person was sixteen. A conventional horoscope, drawn to an elongated pattern (e), was made for the *later* date, while this was then bordered with another set of houses for the earlier date. The result is depicted in outline in Fig. 21. (The original is, as it happens, only a fragment, but

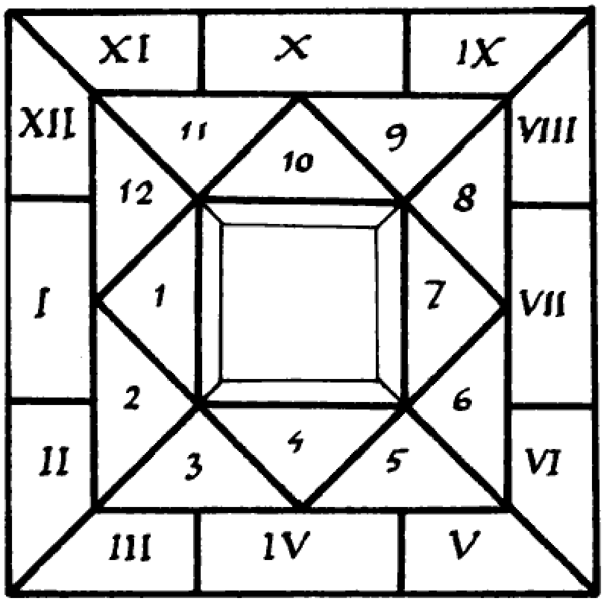

Fig. 21 A typical bordered horoscope, as found in an example for 14 March 1122, from the Cairo Geniza. This particular example is actually triple, with a border around the centre square, here drawn lightly.

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[193] Goldstein and Pingree (1977–81).

[194] The meaning of my notation here should be clear. They label the horoscope simply as 'A', of course, in the 1977 paper.

its plan is clear.) In another example, namely E(1977), where the basic horoscope is drawn to pattern (b) for 23 April 1149, a double border contains details from the nativity horoscope of the native's father. This same concern is found in C(1977), where the occasion is the eighth birthday of a child (18 January 1146), but where the main purpose was evidently to predict the fortunes of the father. Here the border is no longer enclosed within rules. Fragments B(1981), also bordered, embody three horoscopes, one for 14 March 1122, the middle being effectively in pattern (g).[195] F and G(1981) are from the fourteenth century, and contain no drawn figures. The first is for 4 December 1350, and the second is an anniversary horoscope for the same person. D and E(1981) show the practice of month by month interpretation.

These horoscopes offer little by way of interpretation. Their general character, though, shows the continuing popularity of the method of horoscopy at regular intervals, the chief exponent of which technique in Arabic was Abū Maᶜshar, while the technique of using the child's horoscopes to predict the fortunes of the father was developed by the astrologer we met in the last section, ᶜAlī ibn Riḍwān, in his commentary on Ptolemy's *Tetrabiblos*.[196] Goldstein and Pingree include three horoscopes from this commentary as an appendix to their first article, beginning with ᶜAlī's own nativity (computed date 15 January 988).

Some of these horoscopes, needless to say, are straightforwardly calculated on standard lines for the latitude of Cairo, given by Ibn Yūnus and most other sources as 30;00°. Two fragmentary texts from the Geniza, for example, namely H and J(1981), give computations for the standard calculation for the Cairo latitude, and for ascendent and mid-heaven based on the Sun's position. G(1981) was likewise calculated along these lines, as was its base horoscope F. Bearing in mind that these are from the fourteenth century, it is of some interest to see whether Ibn Yūnus is still in use. Goldstein and Pingree note the association of tables of oblique ascension (for $\phi = 30^\circ$) which do agree with those in the *Zīj al-Ḥākimī* of Ibn Yūnus (who favoured $\varepsilon = 23;35^\circ$) and tables of right ascensions which only partially agree with his. This is an interesting test case for mixed tables, which I discussed in part I. The revolution horoscope, if we were to take its cardinal angles at their face value – they are, after all, given to seconds, namely at $\lambda_1 = 192;03,58^\circ$ and $\lambda_{10} = 102;44,50^\circ$ – would certainly lead us to doubt that an obliquity of 23;35° had been used, as we may see from the following table, where five specimen obliquities are given opposite the latitude, deduced in our usual way. The aim here is to approximate as closely as possible to 30°, and had we had not known of the associated tables, we might have opted simply for Ibn ash-Shāṭir's (the penultimate) figure, or the figure above it, which we have seen ascribed to al-Majriṭi in the West.

ε	ϕ
23;51	30;12,29
23;35	30;02,11
23;33,30	30;01,13
23;33	30;00,54
23;31	29;59,37
23;30	29;58,59

The horoscope in question is accompanied by some of the steps in the calculation, but they are not very enlightening, and like so many of these horoscopes, it is lacking in the full complement of house divisions.[197a] Another example, E(1977) for 1149, gives only the signs of the (non-cardinal) house divisions, except for the seventh house. Again, the latitude we deduce is unambiguously that of Cairo, but the deduced obliquity now lies half way between Ptolemy's and that of Ibn Yūnus.

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[195] This is the one illustrated in my Fig. 21, in a somewhat idealized form.

[196] See Goldstein and Pingree (1977), p. 114.

With what are in some ways the most interesting of these Geniza anniversary horoscopes, A and C (1977), for 1066/1082 and 1138/1146 respectively, neither turns out to be for the latitude of Cairo. As first approximations, we can say that A is for a latitude of the order of 44°, while C appears to be for Ptolemy's second climate (23;51°). Both, as far as the fragments go, include house divisions, but they are somewhat ambiguous. The following is a summary of the surviving data from A:

	λ_8	λ_9	λ_{10}
A (inner)	312(?)	335	Aries
A (outer)	345	12	Taurus

Since there is doubt attaching to the inner horoscope of A, we take the outer, and convert the longitudes to right ascensions. If the difference is added to α_9 it gives α_{10}; and if subtracted from α_8 it gives $\alpha_1 + 180°$. We then proceed to the latitude in the usual way. This procedure assumes that the Standard method was used, and of this we cannot be absolutely certain. Repeating the procedure with the inner horoscope we get a reasonably consistent result. Even assuming the Double Longitude method, we are still well clear of the latitude of Cairo. Since there is evidently a reference to the zīj of al-Khwārizmī, we should presumably favour the Standard method, and the Ptolemaic obliquity of 23;51°. In the following table I have rounded to minutes, to take away some of the illusion of accuracy.

	Standard method		Double Longitude method	
	ε = 23;33	23;51	23;33	23;51
A (outer)	44;31	44;28	40;50	40;44
A (inner)	43;56	43;36	43;04	42;43

It would be wrong to go so far as to suggest a place, on the strength of the evidence presented here, but note that we are not dealing with the table of houses found in the western versions of the tables of al-Khwārizmī, which, as we saw, was for a latitude around 39°. I note only that al-Khwārizmī took his people's town of Kunya Urjench to be at latitude 42;10°, which is perhaps on the low side;[197b] and that, like Ibn Yūnus after him, he put Constantinople at 45;00°.

Horoscope C is interesting, simply because it has a full complement of house divisions. Unfortunately, they do not seem to be well calculated on any system. Perhaps the ascendent was calculated, and the remaining houses taken from an astrolabe. An approximate calculation of the latitude suggests a figure between 24° and 25°. This could mean that the cusp longitudes quoted for the houses were rounded data obtained from tables for Ptolemy's second clima (as Goldstein and Pingree suggest), or that some other table was in use, say for Medina. To see how badly calculated the houses would have been, had both latitude and obliquity been taken as 23;51°, I list the correct divisions in the same order as above, taking the ascendent as a datum, and considering both the Standard method and the Prime Vertical method. By dint of the value of the latitude, the results are so similar that we are not able to say that one is clearly preferable to the other. (The Equatorial – fixed bounds – method gives results that are also very close, but slightly inferior to ours.) No doubt the Standard method was that in use.

[197a] In explaining the figure of 193;51, 34° (pp.169, 178), Goldstein and Pingree say that this is a right ascension of the ascendent, given correctly. In fact it is $\alpha_{10} + 90$, which is to say α_0.

[197b] Mr Angus Clarke has pointed out to me note 2 to Ch. 5 of *Ibn Battūta: Travels in Asia and Africa 1325–1354* (ed. anon), 1929 (reprinted 1983), indicating that Khwārizm applied in the middle ages to the town of Kunya Urgench, which the *Times Atlas* gives as 48;18°N and 59;10°E.

	λ_9	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
Standard method:	384.4	17.4	51.8	83.3	(114.1)	140.2	168.4
Prime Vertical method:	348.1	17.4	50.2	83.7	(114.1)	141.3	168.1
MS:	350	17	55	86	(114.1)	143	170

II.7. *The revelational horoscopes of Abraham bar Ḥiyya, and a textual problem*

One aim of this section is the very modest one of showing that in some respects the translation of a part of a work of Abraham bar Ḥiyya (Abraham Judaeus, or Savasorda, in Latin), even though done into Latin through a French intermediary, is more reliable than the extant Hebrew manuscripts. The work in question is the *Megillat ha-megalleh*, 'the scroll of the revealer', and has been both edited by A. Poznanski and J. Guttmann,[198] and translated into modern Spanish by J. Millás Vallicrosa.[199] The fifteenth-century Latin copy (it is only of Book 5), discussed by the editors in their introduction, begins 'Incipit liber Abrahae principis de redemptione Israel' and ends with a note on the translator: 'Completus est iste liber de redemptione filiorum Israel, quem transtulit de gallico in latinum Theodoricus de Northem baccularius (*sic*) theologiae ordinis praedicatorum'. The translation gives no fewer than fourteen different figures for either the ascendent or mid-heaven, in the course of reporting twenty-six horoscopes. Could it be that these differences represent conscious emendations? On checking two at random (W and X in the following table) I derived high northern latitudes, which, in conjunction with the name of the translator (perhaps in his own tongue Dietrich von Northen) suggested that the case was worth investigating. The evident adaptation is an illusion, as it turns out.

The work is one in a long tradition of relating historical change, especially religious change, to the conjunctions of the superior planets.[200] Abraham's attention was focused rather narrowly on the history of Israel, but otherwise his work is in no way very unusual. It is in the general style of the work by Māshā'allāh, discussed in section II.2, but the horoscopes differ, just as they do from the earlier examples in the writings of Mūsà ibn Nawbakht, considered in section I.20. Very little seems to be known of Abraham's biography. He lived in Barcelona, and perhaps in Provence, and died in 1136 or after. Most of his horoscopes deal with the past, but some are predictive, and the latest date on any of them corresponds to A.D. 1444. Most of them are descriptive, that is, lacking a drawn figure, and only two include a full complement of house divisions. Those two (B and V on my list) are calculated according to the Standard method (1). Most give a modicum of planetary information, which I ignore here, as I do those cases where insufficient information is given for us to be able to derive a geographical latitude.

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[198] Meqiẓe nirdamim, Berlin, 1924.

[199] Millás (1929). This includes a translation of Guttmann's (Hebrew) introduction to his edition.

[200] See North (1980) for the background to this movement.

Abraham states quite explicitly that he is accepting a latitude for Israel of 36°, which even by medieval standards is odd, and which probably involves a mistake in copying, as we shall see. (Jerusalem was usually quoted as 32°.) It is unfortunate that the data as to ascendent and mid-heaven are invariably quoted only to degrees, but averaging over twenty-five examples ought to give an indication of the latitude of the tables or other device used. The figures in brackets are the alternatives from the Latin version, and are taken from the editors' introduction. The two cases with an asterisk are the only exceptions, these being my own proposed readings, based on independent evidence in the original. Italicized figures are those where it seems we have a good reason to reject them on the grounds of inconsistency. In two cases (H and S) it is hard to decide between the two alternatives. In one case (X) it seems that the translator (or someone along the route of translation) has made far from intelligent additions, when the original was perhaps lacking in details. Recalling the dangers of trying to extract precise latitudes from data given only to degrees (see section I.7), we can see, nevertheless, a reasonably clear pattern running through the list. Only in four cases out of twenty-five is the derived latitude not within 4° of 34°. Rejecting those cases, and preferring the translation in cases H and S, we find as a mean of the 21 other cases a latitude of 34;08° with a standard deviation of 1;43°. This is with an assumed obliquity of 23;35° (since Abraham is known to have relied in some of his work on al-Battānī); but even had we taken 23;51° (he was certainly also familiar with the works of al-Khwārizmī), we should have been well within a degree of the figure above. The fourth clima (Rhodes) is for Ptolemy's obliquity 36°. It seems more

	Page refs edn/trans.	λ_1	λ_{10}	ϕ deduced
A	119/197	122°	22°	33.79°
B	120/197	_122_ (140)*	44	_19.22_ (35.47)*
C	122/201	268	198 (_208_)	36.41 (_47.25_)
D	123/203	268	192	27.64
E	127/209	248	169 (_179_)	30.64 (_44.22_)
F	129/211	_204_ (207)	121	_49.29_ (37.74)
G	129/211	_126_ (130)	33	_21.25_ (32.24)
H	130/212	42	296 (297)	35.68 (33.15)
J	132/215	148	54	34.60
K	132/216	129	31	33.74
L	132/217	304	232	33.00
M	134/219	32	306	34.60
N	135/220	276	205 (_195_)	33.37 (_16.23_)
O	136/223	261	_184_ (188)	_28.44_ (34.42)
P	139/228	168	77	33.07
Q	140/229	108	5	32.06
R	141/231	78	328	34.11
S	142/233	295 (298)	227	37.75 (33.34)
T	143/234	192	104	41.23
U	146/238	16	279	37.70
V	148/241–2	303	_235_ (232)	_39.86_ (34.61)
W	151/246	_94_	_354_ (_324_)	_21.49_ (_54.75_)
X	152/247	Sag. (_247_)	Lib. (_195_)	— (_57.61_)
Y	152/248	191	_101_ (102)*	_23.12_ (33.97)
Z	153/250	_204_ (206)	119	_43.39_ (34.69)

likely that Abraham used a table for Damascus or Baghdad, if he used tables at all, rather than some other means, such as an astrolabe. Our main conclusion, though, is that when there are variant readings, we more often than not prefer the reading of the translation.

One of these horoscopes will be discussed again in a later section (II.26), in connection with Christ's nativity.

II.8. *Some Norman horoscopes*

I come now to some European horoscopes from the later twelfth century,[201] a time of a rapid growth of interest in Greek and Arabic sources of astronomical and astrological knowledge. Astrology was valued and seen as an essentially Eastern phenomenon. Scholars in the West, who had learned to treat mathematics as a propaedeutic to physics, were greatly impressed by the mathematical skills of the Muslims, and it is therefore hardly surprising that so much effort was put into the translation of their works. Astrology was valued in more senses than one. Hermann of Carinthia and Robert of Chester who were met by Peter the Venerable in Spain studying the science, were hoping to derive remuneration from it.[202] Al-Khwārizmī's astronomy, having achieved a certain cachet in Egypt and Spain, was propagated in the rest of Europe in the twelfth century by Adelard of Bath, Petrus Alfonsus, and Abraham ibn Ezra. Firmicus Maternus's *Mathesis*, with its parts devoted to horoscopic interpretation, had been known from the eleventh century – Daniel of Morley even ascribed it to the Arabs. Although it contains a horoscope, indeed the only known Roman horoscope, this is extremely rudimentary, and does not even list degrees within signs.[203] The work of al-Khwārizmī satisfied a clearly felt need, even though Bishop Michael of Tarrazona found the new tables beyond his powers of understanding – for which reason Hugh of Santalla made for him a translation of Ibn al-Muthannā's commentary.[204]

The two scholars who did most to introduce the all-important al-Khwārizmīan tables to England and Europe (outside Spain) were Petrus Alfonsus and Adelard. The epoch adopted by Petrus was evidently 1 October 1116, while Adelard's version seems to date from 1126.[205] Adelard's work on the astrolabe, with its clear instructions as to the evaluation of the division of the zodiac into houses (the *Standard* method) was produced in the 1140s (perhaps 1149) at Bath.[206] Belonging perhaps to the 1140s is Robert of Chester's revision of the Adelard-al-Khwārizmī tables;[207] but then, as mid-century approached, there came a breath of novelty. Tables for London, based on the Toledan tables, have a preface dated 1149. This was a full decade before Abraham ibn Ezra's visit to that city, and nearly three decades before Roger of Hereford's tables for Hereford (1178).[208] Although the latter were based on those for Toledo and their derivative for Marseilles,[209] neither they nor the 1149 tables managed to replace their predecessor at all quickly.[210]

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[201] The main body of this section is to be published in a volume edited by C. Burnett. I should thank Dr Burnett for allowing its inclusion here.

Earlier European astrology has been as yet little studied, but see the conspectus in van de Vyver (1936). Note that at least canons for the *Handy Tables* of Theon were known in this period, besides which there were several good treatises on the astrolabe available in Latin translation, and they of course had astrological possiblities.

[202] Kritzeck (1964), p. 212.

[203] Neugebauer (1953), pp. 418–20.

[204] E. Millás-Vendrell has edited this (Madrid, 1963).

[205] Neugebauer (1962), pp. 139, 218, 232.

[206] See p. 105 below.

[207] See Haskins (1927), p. 123, for its lengthy rubric.

[208] Ibid., pp. 122, 125.

[209] E. Poulle, in his DSB art. 'Raymond of Marseilles' (vol. xi, pp. 321–3), notes that the adaptation was made nearly thirty years before Gerard of Cremona's translation of the Toledan tables. Did Roger know them other than through the Marseilles version?

These brief chronological notes, seen in the light of earlier discussion of the relevance of the works mentioned, should give some idea of the techniques available to the best astronomers at various points of the twelfth century. The evidence as to the use actually made of those techniques is unfortunately very sparse. C. H. Haskins has drawn attention incidentally to a handful of horoscopes, and J. D. Lipton, supplementing them with others, has brought the total to no more than fifteen.[211]

I begin with the most important group, to be found on the two defective and largely illegible end leaves of British Library MS Royal App. 85.[212] These are ten in all, and lettering them as does Lipton, they are as in the following table. I have adopted my own readings.

	fol.	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
A	1r	23;31	[56;15]	60;51	124;00	148;45	175;05
B	1va	[180;04]	206;18	230;29	253;00	286;36	322;05
C	1vb	65;55	95;41	126;00	159;00	189;09	218;27
D	2ra	[183;36]	208;38	232;40	255;00	289;40	324;27
E	2rb	105;54	133;18	162;57	194;00	226;50	256;56
F	2ra	275;24	304;41	336;20	10;00	40;38	68;47
G	2rb	79;49	108;20	138;20	171;00	201;32	232;18
H	2va	217;17	240;32	262;38	284;00	319;20	358;08
J	2vb	116;28	143;45	173;06	203;00	236;02	266;26
K	2vb	95;40	123;19	153;10	185;00	217;30	247;28

First some general remarks about the form of the horoscopes. They are drawn freehand, without the use of a ruler or much care. That we are dealing with an autograph, which required the investment of many hours of work – something that might seem difficult to reconcile with the casual drawing of the squares – is clear not only from the general form but from the many erasures. A later owner has cut away what I suspect was only unused parchment; the double leaf was originally bound into the manuscript, with which, however, it has no textual link. The last horoscope of the ten, K, is in a different hand – we shall find a somewhat later date for it than for the others – and is drawn in form (b) of Fig. 1. For this there are many Arab precedents. C and E approximate to form (e), while the others are in form (d). Note that B and D are close in configuration to one another. In fact both make the mistake of giving the sign under mid-heaven as Virgo rather than Libra (lower mid-heaven is correctly given as Aries), this fact probably indicating a mistake in the copy of whatever tables were used. In the case of B, the scribe uses the special sign for zero, '*figura cifrae*' in the canons of al-Khwārizmī, where we are told how to use it.[213] As for the type of table used, this is easily found. By our usual method for geographical latitude, every example yields a figure between 37° and 39°, apart from F, which gives something of the order of a degree higher. This fact leads us immediately to the tables of the houses associated with the tables of al-Khwārizmī (ed. Suter, tables 79 to

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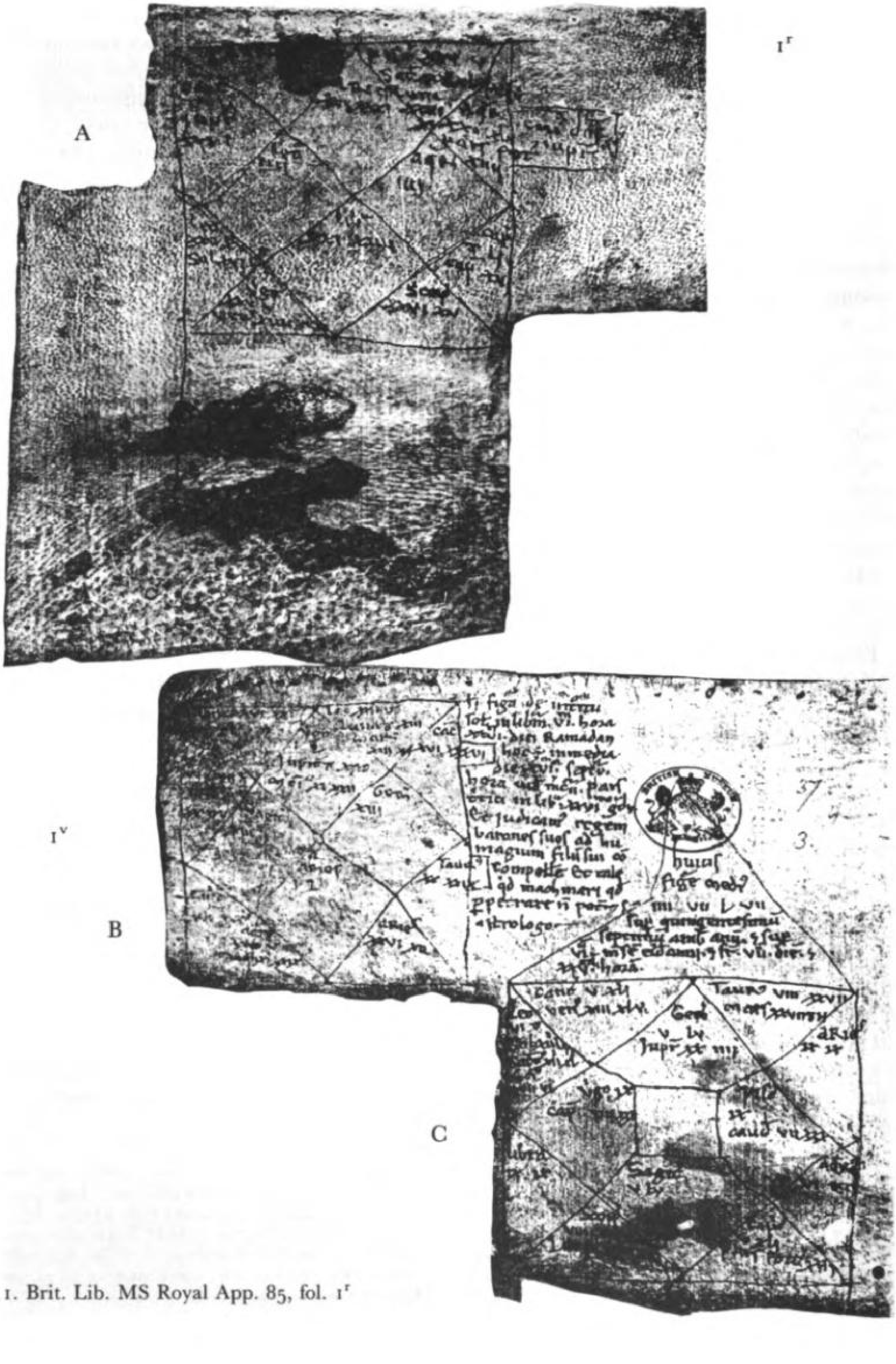
[210] They are with tables for Hereford in MS Madrid 10016 (13th century) according to Haskins, loc. cit.

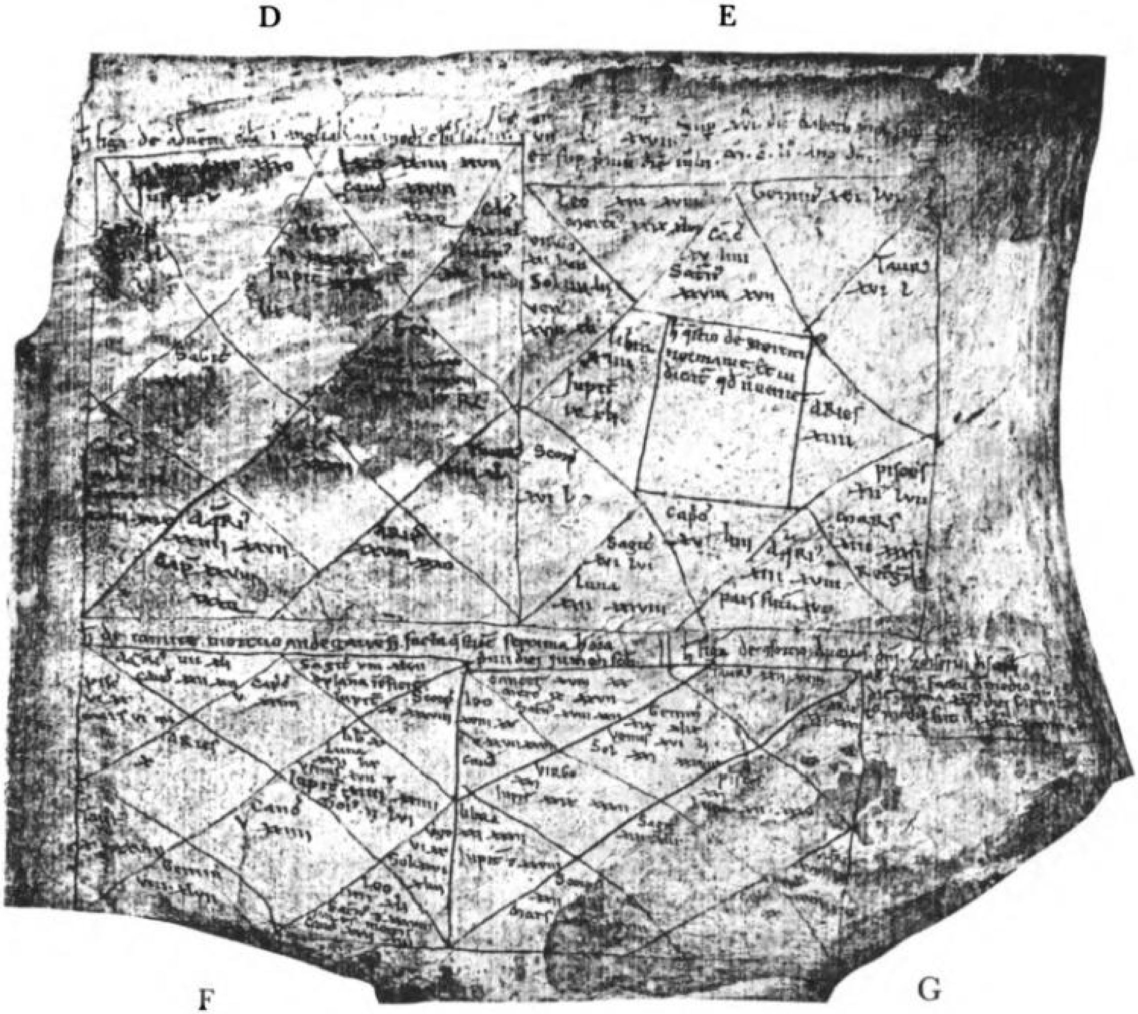
[211] Lipton (1978), pp. 210 ff.

[212] I have to thank Mr Peter Jones of the Department of Manuscripts, for obtaining photographs of these for me.

[213] Although written like a rather small uncial letter *t*, with the lower part curved up to close the circle (so that it resembles the circle with 'horns' that is used to represent the sign of Taurus), and although the letter *t* had been used with Roman numerals to denote zero, *t* being the initial letter of 'terminus', there is no doubt that in our context the symbol is a special importation from the al-Khwārizmī quarter. See, for instance, the edition of Suter (1914), chapters 7 and 8 of the canons.



Pl. 1. Brit. Lib. MS Royal App. 85, fol. 1ʳ



Pl. 2. Brit. Lib. MS Royal App. 85, fol. 2ʳ

90), which, as I have already explained, are hybrid tables, probably intended for Córdoba.[214]

Turning to those tables – which are by the usual rules of the game uterly inappropriate to northern latitudes, of course – it is a simply matter to verify the readings obtained from the manuscript. Fourteen out of the sixty (independent) readings differ (overlooking the Virgo/Libra error), but invariably in trivial ways, obviously dependent on the hazards of reading and copying roman numerals. There is not the slightest doubt that the supposed Córdoba table was the one used in the preparation of all of these horoscopes; and it would not be too much to say competently used, apart from the fundamental blunder of working from tables for the wrong latitude. One wonders how an astrologer could justify working to minutes of arc under these circumstances. It rather seems that the tables had a mystique which detracted from their mathematical rationale – or was it that they were used in an act of desperation, since nothing else was available? There are no obvious answers to these questions.

To try to discover who was responsible for these horoscopes, and under what

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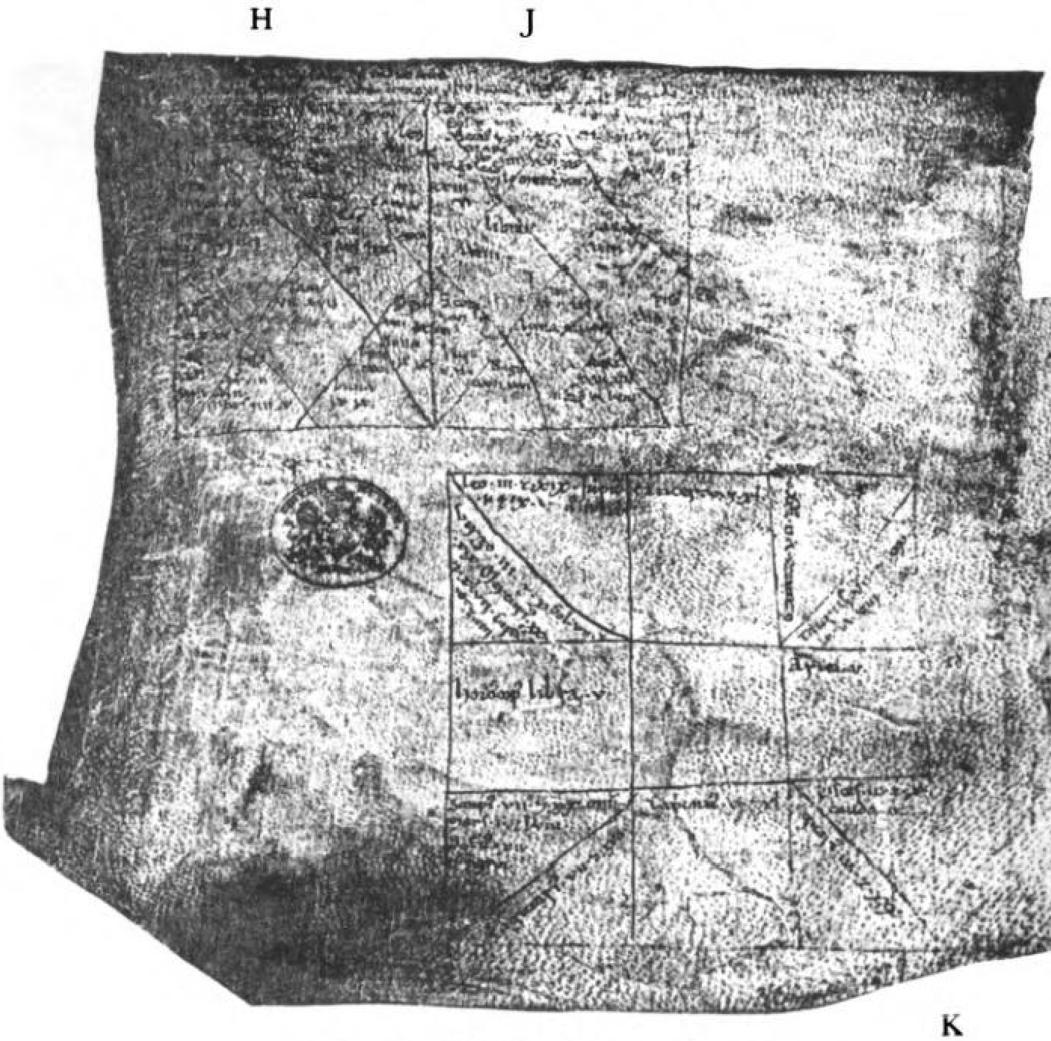
[214] See pp. 27–8 above.



Pl. 3. Brit. Lib. MS Royal App. 85, fol. 2^v

circumstances, we should consider the associated, very peremptory, comments written alongside some of them. As far as it is possible to make these out, they are as follows:[215]

B. Hec figura de introitu solis in Libram, .vi. hora .xxvi. diei Ramadan, hoc est in media diei .xvi. Septembri.[216] Hora indictione Mercurii pars tertia in Libra .xxvi. gradu. Et iudicamus regem barones suos ad humagium filii sui compellere,[217] et tale quid machinari quod perpetrare non poterit sine astrologo.

C. Huius figure medius iiii vii l vii super quingentesimum septimum[218] arabum annum et super .vi.ª mensem eiusdem anni et super .vii.ᵐ diem et .xxv.ᵐ (?) horam.

D. Hec figura de adventu cuiusdam in Anglia. Casus (?) medius cursus Solis (?) .iii.ˢ

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[215] A and K have nothing. H has a long (about 19 words) and J a short (about seven words) rubric written above. Although I can make out fragments of the texts under ultra-violet light, I cannot extract enough to make out their meaning. H seems to be numerical, in the style of D. J begins 'Hec figura de . . .' and might conceivably continue 'pactionis . . . ali in dominio'.

[216] Lipton reads 'die. xxvi. Septembri' and notes that 26 Ramadan was never equivalent to 26 September in the twelfth century. See my comments below, on this problem.

[217] MS *comcompellere*.

[218] Lipton notes that the planetary positions require this to read *septendecim* (i.e. to be for A.H. 517, not 507).

.vii.^{g} .xi.^{m} .xxvii.^{s}[219] super .xvi.^{am} diem Ribeth primi super .xv.(?) . . . et super primum diem Iulii M.° C.° Li° anno Domini.

E. [Within the square:] Hec questio de exercitu normanie. Et iudicatur quod non veniet.

F. [Within the square:] Hec de comite mortuo[220] Andegavensi facta questione septima hora primi diei Jumedi secundi.

G. Hec figura de consortio duorum, scilicet domini et dei servi[221] discipuli, ac fuit factum in medio die .i Luna .xx. dies Saphar, cuius medius fuit .ii.^{s} .xiii.^{g} .xxxiiii.^{m} .xii.^{s}

The historical information here is minimal, but its dating is of some interest. Among other things, we shall find ourselves confronted with one of the greatest of hazards in reading a horoscope, namely that of assigning a planet to the wrong sign. I think J. D. Lipton has done this in the strictest sense in twenty-seven cases, but our twelfth-century astrologer has himself paved the downhill path. Take, for example, horoscope H, and the Moon, which he placed in *both* houses 5 and 6, with coordinate 9;9°. The reason is obvious: the Moon was, he supposed, at Gemini 9;9°, and both houses 5 and 6 have 'Gemini' written in, as the sign in which they begin. Only one of the two houses in this case actually contains a ninth degree. In many cases he was likely to make a mistake and leave it uncorrected – as are we. Thus Lipton took Saturn, in A, to be at Pisces 21;45°, because its coordinate 21;45° is there written under the coordinate *Pisces* 25;05° – yet this latter is the coordinate of the *beginning* of the house (the ninth), which ends at Aries 21;31°. Reading Saturn's coordinate – as I think we should – as 20;45°, it will just fit into the house. I am quite certain, however, that some at least of the planetary positions are wrongly given by the author himself. We can easily show that he made this sort of mistake in horoscopes A (for the Moon) and G (for Mars), since the coordinates stated are not possible within the houses in which they are written. It is extremely difficult, if not impossible, to say how often this sort of mistake has been made. It is most crucial when it affects the slow-moving planets Saturn and Jupiter, on which we rely most heavily for purposes of dating. Lipton could not find dates for A or B, for instance, but if the astrologer was accurate Lipton had made mistakes of the sort described in both cases. As a check on planetary coordinates it is always wise to record the house in which it is found, and this I have done in the table of planetary positions. In Fig. 22 there is an indication of a way in which many astrologers avoided the difficulties here outlined.

From this table we may make estimates of the dates for which the horoscopes were cast. A first approximation may be found using a modern ephemeris such as that by Bryant Tuckerman.[222] Ideally one's findings should be verified by (in this case) the use of the tables of al-Khwārizmī, which we know to have been used, but in practice the planetary data in the horoscope are so erratic – whether through miscopying, miscalculation, or both – that nothing is gained by the check.

The best approach to the problem of dating the horoscopes is through the seven cases in which the positions of the ascending node of the Moon's orbit (*caput draconis*, abbreviated to *caput*) are quoted. The reason is that the longitude of *caput* was easy to

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[219] The superscript above .xxvii. seems to suggest minutes, while that above .xl. is illegible. Lipton reads the planet as probably Saturn, and the position as probably 7^{s} 11^{s} 27^{m}. He associates this sentence with E, which is not compatible with either the position of the Sun or that of Saturn. In D, however, the Sun seems to be at Gemini 18;38°.

[220] Word omitted by Lipton.

[221] I thank Mr Peter Dronke for this reading. The two words are run together in the MS, and look like *diservi*.

[222] Tuckerman (1962–4).

	Derived date	Caput draconis	House	Saturn	House	Jupiter	House	Mars	House	Venus	House	Mercury	House	Moon	House	Sun	House	
A	early Sep. 1135	285;00	6	20;45	9	81;01	12			194;24	3	om.		353;11[e] 150;13	9 9	172;00	2	A
B	16.9.1151	329;29	3			190;28	10					191;22	10	120;13	8	(180?)	9?	B
C	2.8.1123	187;30[a]	1	132;40	12	80;04	10	58;00	9	103;45	11	137;06	12	233;13	3	132;50	12	C
D	6.6.1151	328;34		110;59	8	206;59[a]	10			101;35[a]	7	78;55[r]	7	293;29[z]	2	78;38	7	D
E	23.8.1151	om.		118;17	10	219;41[a]	1	343;32[r]	6	168;41	12	149;46	11	262;38	3	184;52[a]	12	E
F	15.9.1151	322;13	11	150;38[a]	5	194;24 179;32	7 1	6;04[a]	12	197;00	7	200;56	7	202;59	7	176;43	6	F
G	8.6.1151	327;27	6	108;22	11	218;28[b]	2	231;23[c]	3	106;51[a]	10	129;27[a]	11	12;53[a]	7	81;38	10	G
H	30.9.1151 or 1.10.1151	352;32[ga]	2	153;00a	8	230;41[a]	10	4;10[a]	3 11		12			69;09	5[f]			H
J	30.8.1150	336;58	5		11		11	159;14	2	om.			10	252;00	2		11	J
K	23.8.1160	150;04	11	222;36	2	151;10[a]	11	241;58[a]		d		170;47	12	38;13	8	157;19	12	K

a. The sign allocated implies this longitude, but a long. of 30° less was intended. See text.
b. See text. Take the *lower* reading.
c. Implies that the planet was put in the wrong house. No alternative reading possible.
d. I do not see Venus. Lipton has 122;40.
e. Moon put in wrong house. No alternative possible.
f. The Moon was also put into house 6.
g. Derived from the position of *cauda draconis*.
r. Retrograde motion indicated in manuscript? If so, in error.
z. A sign too low. Cf. a.
om. Omitted.

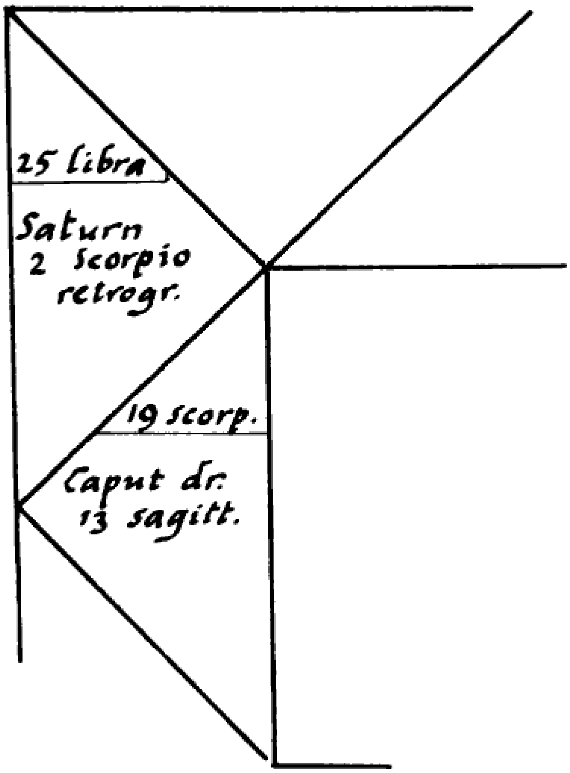

Fig. 22 One of the conventional ways of indicating that the planet is not in the same sign as the cusp of the house. This example, redrawn from MS Hertford Coll., Oxford, E.4, f. 3^r, indicates that the cusps of houses 12 and 1 are Libra 25° and Scorpio 19°, respectively, and that Saturn is at Scorpio 2° (and with retrograde motion), while the Moon's ascending node, caput draconis, is at Sagittarius 13°. Often the planetary sign is not shown, the dividing lines (the horizontals in this example) being supposed enough to instruct the reader to pass into the next zodiacal sign.

Although MS Hertford E.4 is a fifteenth-century manuscript, the convention was used long before.

calculate, since it decreases *uniformly* with time. I give here a brief summary of the procedures I have followed in dating all of the ten horoscopes:

From planetary positions the dates of D and K are found, since they give the impression of being largely unambiguous. The dates turn out to be 6 June 1151 (Julian day no. 2141617) and 23 August 1160 (J.D. 2144983). That they seem to be by different hands will prove in the end not to affect the consistency of their readings for *caput*. By linear interpolation and extrapolation estimates are made of the dates of A, D, F, G, and H. The parameter implied for the retrograde movement of *caput* is good, but is much improved if we modify *caput's* position in D from 328;34° to 327;34°, and this spares us the need to modify the other readings by a degree, as the planetary positions would suggest that we do. A degree represents about 19 days movement of *caput*, and the planetary positions are well able to take care of all but an uncertainty of three or four days. In principle they allow precision to better than an hour (taken together with the houses), but in practice miscalculation and miscopying and the error of sign through placing a planet in the wrong house, as already explained, all stand in our way, as does damage to the manuscript. The problem of indicating the wrong sign is serious. After careful weighing of the evidence we are able to show that such errors of sign were indeed made by the astronomer in sixteen cases (marked in the table with a superscript *a* or *z*), some of which

Lipton adopted, adding others of his own – an easy thing to do. The positions of *caput* of course gave us dates only modulo 18.6 Julian years. Horoscope A is the only one where this is a real problem, simply because it is so inaccurately calculated.

Note that B, F, and H are very close in date. Their separation can be evaluated by the small planetary shifts between them, once we know (from Tuckerman's tables, for instance) approximate daily movements at about this time. Just as we aim to reveal an internal consistency between planetary positions and the position of *caput* within a single horoscope, and a general consistency of *caput* positions, so we look for a general consistency in planetary positions. Note how wide of the mark is the Moon's position in B. The date within the month (16 September) of B is obviously correct, since it corresponds to 26 Jumedi II. Admittedly the text says 26 Ramadan, but this must have been an error: the coincidence of correspondence of dates of 26 and 16 is too strong to be rejected, for this is a rare enough event, and in any case the date offered was derived quite independently. As for the other quoted dates in the era of the Hejira, those for C, F, and G (see the Latin captions to them) correspond perfectly, while in D we should read 23 Ribeth for 16 Ribeth.

Horoscope J is a difficult one to solve, but I am confident that it is more or less right: the longitudes of the Moon and Mars are more or less right: the longitudes of the Moon and Mars are more or less acceptable, while *caput*, Jupiter, and the Sun are in the houses indicated on the MS, on the date offered, even though their longitudes are now illegible.

By these methods I confirm Lipton's dates for C to G, inclusive, add new dates for A, B, and J, and revise somewhat his dates for H and K. A more thorough treatment would use the tables of al-Khwārizmī.

From the dates derived it is evident that the horoscopes comprise a strongly homogeneous collection. We can take it that Stephen was the king obliging his barons to pay homage to his son (horoscope B, 1151). Stephen had been on the throne from December 1135 (my date for A is September 1135) and would be so until 1154. We recall that although he claimed to be the rightful heir to Henry 'Beauclerc', his descent from the counts of Anjou represented to many a troubling change of dynasty – hence the great significance of the act of homage, in the astrologer's eyes, no doubt.[223] (Stephen's son Eustace died in 1153, by which time Stephen's dynastic hopes were fast dwindling to nothing.) Matilda's second husband Geoffrey Plantagenet, count of Anjou, was presumably the subject mentioned in horoscope F, and perhaps even the subject of D (6 June 1151). He died suddenly on 7 September 1151, hence the topicality of a question about a deceased count in F, done – it would appear – eight days later. Perhaps something was amiss with the astrologer's chronology. It had been a long-standing question, whether or not Geoffrey would come to England (cf. the caption to D), but in fact he was needed in Normandy, where he stayed to complete his conquest, added to which he had a rebellion to deal with in Anjou itself.

If D concerns a judgement as to *whether* a certain person will come to England, rather than one concerning the results of their coming, then a candidate might be Matilda's and Geoffrey's son Henry. He came in 1142–3, 1146–7, and 1149–50 – the precise dates are uncertain. Geoffrey transferred the duchy of Normandy to him in 1150, when he was seventeen, and Louis of France invested him with Normandy and his father's hereditary dominions in the summer of 1151. As we have seen, he became master of them on

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[223] For the general background to this section see such works as Poole (1975) and Le Patourel (1976), esp. pp. 89–117.

7 September of the same year. Was the transfer of Normandy the occasion of horoscope J, datable at 30 August 1150 ?[224] In England, Stephen was still in control, and there was stalemate until 1152, at least.

It seems likely that *all* of the horoscopes apart from K – perhaps even G, concerning a partnership of master and pupil – were meant as aids to such politico-astrological interrogations as that (E) showing concern over whether or not a Norman army would come. It was to come, of course, with Henry in 1153. Faced with it, Stephen agreed to disinherit his own son William – one of the many provisions of the treaty of Winchester. On Stephen's death in 1154, Henry succeeded to the throne. As to the significance of horoscope K (23 August 1160), this is hard to guess, but its relevance to the group cannot be dismissed, since it seems to have been cast for the same day of the month as E, but nine years on.

The earliest date – 2 August 1123, for C – is hard to place. Henry I went to Normandy in that year, and there was then a rebellion in support of the claims of William the Clito, son of Robert of Normandy (whom Henry had defeated at Tinchebrai in 11601). Whether there was some significant occurrence on 2 August, I have not been able to discover. It is rather important here that we try to determine the allegiance of the astrologer casting these horoscopes. Was he Stephen's man, fearing a Norman invasion, or Matilda's man, looking forward to it? The first of these alternatives is almost certainly the one to accept, since in B we find him judging that the king should compel the barons to pay homage to his son, and being evidently proud of the help he could offer. If C was connected with Henry's journey, then presumably it was to celebrate a blow against an older rebel Norman cause. (I doubt whether it is a nativity. Stephen's eldest son Eustace was born six or seven years later, and the future Henry II not until 1133.) One can reasonably suppose that if horoscope C was for Henry I's expedition, then it was – since the manuscript is English – done from an English point of view; but even if the astrologer was Stephen's servant, that need not be taken to imply hostility to the future Henry I, and there is at least a case to be made out for the involvement of one particular astrologer who is thought to have been on good terms with Henry – namely Adelard of Bath himself.

As we have seen, Henry's star was emphatically in the ascendent in the summer of 1151, which seems to have been the time of casting of perhaps all but the last of the horoscopes. He was his grandfather's chosen successor, and the English witan had been made to swear him fealty soon after his birth – this, as it turned out, being shortly before Henry I's death. In 1142, at the age of nine, his uncle Robert of Gloucester brought him over to England to join his mother, and for the next year or two he was educated in the Bristol house of his uncle by a certain Matthew.[225] It used to be assumed, following Haskins, that when Adelard of Bath dedicated his treatise on the astrolabe *Henryce cum sis regis nepos*, if this was not to Henry of Blois (which seems unlikely)[226] it was to the future Henry II during the period 1142–6. Following better information about Henry's movements, gleaned by R. L. Poole, we know that this first period has to be drastically shortened. He came again to England in 1147, for only a short period – but long enough to make some unsuccessful raids into the north of England, and have Stephen, as a kinsman, provide money to pay off his disgruntled band.[227] On a third visit, in 1149, lasting to some date between November 1149 and March 1150 (when he was in Normandy to be invested with the Duchy by his father), he was knighted by another kinsman, David of Scotland (22 May 1149). On this occasion, Stephen's allies laid an ambush, which he avoided, reaching Bristol (the Plantagenet centre of operations) in safety. In retaliation, Stephen laid much of the west of the country waste.

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[224] If the word in the rubric to J (see n. 215 above) is *pactionis* (*pactio* being a classical word for a contract or treaty), this might be thought support for the interpretation.

[225] The most reliable information on Henry's movements, undermining the records of Gervase of Canterbury by, in many cases, providing Angevin and Norman evidence as to Henry's presence on the continent, is Poole (1932).

[226] Henry of Blois, grandson of William I through his daughter Adela, by 1126, aged 26, was abbot of Glastonbury. (We take this to be the date of the canons and tables of Al-Khwārizmī, in the Adelard version, referred to in the Astrolabe).

This information is important for the dating of the astrolabe treatise and, as I believe, for the correct placing of our group of ten horoscopes. There is a critical passage in the treatise on which there seem to be two schools of thought. The drift of this is that those born and raised in the palace of the world and who decline to discover the reason for its marvellous beauty (a) so declining after the age of discretion they should be cast out, if possible; *or* (b) having so declined before the age of discretion, should if possible be cast out afterwards. The former reading is Dickey's, the latter Haskins', if I understand them correctly.[228] Haskins decided therefore that Henry was not yet sixteen, Dickey that we should look for a date near his sixteenth birthday (4 March 1149), which seems to me plausible enough. (The very mention of the age of discretion might have been thought to indicate that a time a little before or after his sixteenth birthday was called for.) The third visit is thus favoured as the occasion of the dedication; but it must be admitted that the slightest breath of new evidence might blow over the conclusion.

Whether or not it was during this third period, it seems likely that Adelard taught Henry while he resided at Bristol, that he looked upon him as a future English hope, and that with this proven court connection, not to mention a rare expertise that would have enabled him to cast nine of the ten horoscopes, he is our strongest candidate for their authorship. Indeed, the thought that he was their author leads me to make a conjecture as to the authorship of the tables of houses, which as I explained seem to be for Córdoba. Adelard mentions only two Arabic authors in his astrolabe work, one of them 'Almirethi', namely al-Majrīṭī, the greatest of the Córdovan astronomers during the Caliphate. (He died c.1007.) It is not improbable that he was responsible for the tables of houses.

I can see only one other scholar of the time whom we have reason for thinking capable of expert astronomical calculation, namely Robert of Chester, but we know of no firm royal connection in his case. That other element is also lacking, namely proximity to Bristol. If Adelard cast the nine horoscopes that seem to go together, namely A to J, it is natural to suppose that G, the figure concerning the association of a master and a devout pupil (*Dei servus*) might relate to Adelard and Henry. It would have been cast, according to the dates found above, within two years of the *Astrolabe* dedication. What about Adelard's age? While we do not have to take seriously the attempt by F. Bliemetzrieder to associate Adelard's name with the 1160 translation of *Almagest* (his age apart, there is only a reference to an anonymous Englishman to go on), he would only have been around seventy years old in 1151 – old, but not, perhaps, too old for the exercise in question.[229] Arguments *ex silentio* are always dangerous. No doubt there were other scholars of whom we know nothing, capable of handling the tables of al-Khwārizmī and concerned with affairs of state. We know as little about twelfth-century astrological practitioners as we know of the demands of their clients. One obvious way in which our picture is blurred stems from the essentially private character of nativities, which for lesser mortals tended not to be bound into scholarly codices, at least until the end of the middle ages. Royal horoscopes have always been in a different category, and it is worth recalling that Babylonian divination was directed at the state and the ruler long before astrologers began to pander to the needs of the private client. Royal horoscopes continue, it seems, to be of general concern and interest. If this extends to my twelfth-century examples, then be it noted that Adelard scholars who are prepared to accept them as his are at the same time virtually obliged to accept the document containing them as an Adelard autograph.[230]

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[227] Poole (1955), pp. 151–2.

[228] Dickey (1982), pp. 11–12.

[229] On the question of Adelard's age, see the art. by M. Gibson in the forthcoming volume by Burnett.

Astrological interest in the affairs of the Normans was not restricted to contemporary scholars. In passing, I might mention a horoscope calculated by Francis Bernard and sent with a letter from Bernard to William Lilly on the horoscopes of cities, now in Ashmole MS 242.[231] Bernard, a physician who likened fires to fevers in men, was of the opinion that major outbreaks of fire could be predicted from such horoscopes; and since the precise moment of the foundation of London was uncertain, he was obliged to rectify its figure with the help of the known history of the city including the Norman conquest. The great fire of London was two years in the future when Bernard wrote. It raged between 2 and 6 September 1666. William had sailed from Normandy on 27 September 1066. The battle of Hastings was fought from sunrise to sunset on October 14. The horoscope is accompanied by no explanation, but I imagine that the juxtaposition of the dates I have mentioned, taken together with Bernard's principle, provided the occasion for its casting. Since it preceded the event—the letter is dated 27 May 1664—it is all the more remarkable! It bears a simple colophon, 'Incipit Imperium Normannorum', and may be summarized as follows:

λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon
280;30	295	323	26	69	87	162;59	151;58	251;51	206	196(?)	212;49	121
						(163;03	152;09	252;40	206;01	209;35	212;44	119;46)

The lower line records the actual positions of the planets at noon on the day of the battle. The calculation was extremely creditable – much better than Lilly's usual efforts. The reason for supposing this to be Bernard's work is that other horoscopes for cities and their institutions, London fires, the Gunpowder Plot, and so on, are in the same volume on the same printed forms.[232] As for the houses, they are calculated according to the style fashionable in England at the time, namely to the Equatorial (fixed boundaries) method, the method popularized by Regiomontanus, sometimes called the 'rational' method. Here some of the data have slipped by a degree or so. The accepted latitude is found to be 51° (Hastings is 50;49°).

Francis Bernard was later to become a fellow of the College of Physicians and physician to James II. Whether he received the same treatment as Lilly, in being hauled before the Committee set up to examine the causes of the Great Fire, does not seem to be on record.[233]

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[230] As mentioned earlier, the document has all the characteristics of an autograph – irregularity, a failure to plan the page in advance, and not even the ruling of lines. Note too the erasures, over which new numbers are written (in the original hand). An authority on these matters, Dr E. Poulle of the École Nationale des Chartes in Paris, is in no doubt about this point.

[231] The horoscope is at f. 80r, and the letter is at f. 85. It is one of four figures which some writers have wrongly supposed to be Lilly's.

[232] They are on sheets on which a blank figure, printed from an engraved plate in a characteristic style, has had the specific details written in by hand.

[233] Lilly (Briggs ed., 1974), pp. 88–90, records the affair.

11.9. *A nativity by Abraham ibn Ezra, and fourteen spurious examples illustrating a point of printing history.*

Apart from the ten horoscopes already mentioned from the twelfth century, Lipton lists five others. Two of them (N and O) come as Plato of Tivoli's 'signature' to two different translations, one of Abū 'Alī al-Khayyāṭ's *Nativities* (dated 15 July 1136) and one of Abraham bar Ḥiyya's *Liber Embadorum* (dated 7 August 1145).[234] They appear to have been left without house divisions. Another (M) is a horoscope in one William's *Microcosmographia* in MS Trier 1041.[235] According to Lipton the horoscope seems to be an impossible one, as regards the planetary positions. It was supposedly for 1178. I note only that the accompanying text, taken with the Córdoba table of houses in hand, makes some sense if the ascendant was Libra 2°; but the matter is not worth pursuing. A French manuscript with a horoscope relating to the birth of a boy on 29 October 1136 (which Lipton rightly suggests should be amended to 1135) has the houses given to degrees only.[236] This horoscope (P) will be examined shortly. Finally, there is an example (L) concerning an unusual occurence on 16 September 1186, when all the planets were to be found in the sign of Libra. It was ascribed by Roger of Hovedon to William, clerk to John, the constable of Chester.[237] The houses are given to degrees, and seem to be either very corrupt or to have always been pure nonsense.

The birth horoscope (P) is particularly interesting, because, although concerning an event in 1135, its author might have been using tables of houses a fragment of which we found in MS Laud misc.644 in association with the Toledan tables there.[238] We are led to these automatically. Applying our standing procedures for finding the latitude from the ascendent and mid-heaven (see the first row in the following lists of longitudes), we find a little over 41;09° with the Ptolemaic obliquity and a little under 41;25° with 23;33,30°. Turning to the manuscript tables (which fortunately cover the case in question) we find the values in the second row:

	λ_{10}	λ_{11}	λ_{12}	λ_{1}	λ_{2}	λ_{3}
(P)	167	192	213	241	273	309
(Tab.)	167;01	192;40	217;29	241	274;45	309;06

Dropping the minutes, three derived values fit exactly, and the other two would be explained by the miscopying of roman numerals, *if a table was indeed used*. The Córdoba table that we found in use for the Norman horoscopes, incidentally, does not give a single figure in agreement.

The fact that the houses are given only to degrees could of course mean that an astrolabe was used – although it would have been a rather good one, to give the accuracy we have shown present. Even in this case, however, our derived latitude tells us something of historical interest. The interpretation of the nativity (P) ends with the words 'Hanc nativitatem iudicavit Abraham Judeus Biterris'. This is a reference to Abraham ibn Ezra of Béziers. Now the latitude of Béziers is 43;20°, and accurately used would have given appreciably different data for the houses. Whatever the place of birth, the fact remains that Abraham was using tables for a latitude that if Italian would bring us to the south of Rome, and if in the Iberian peninsula, to the south of Barcelona. If we are allowed to link the horoscope with the table, then we should take the lower latitude, for we found the Ptolemaic obliquity to have been used. Dr R. Mercier finds that the planetary positions are better represented by Ptolemaic calculations than by Toledan, a welcome reinforcement of the tradition in which the table of houses was placed.[239] Abraham was a traveller, as we know, and between 1140 and 1167 he visited Rome, Salerno, Lucca, Pisa, Mantua, Verona, Béziers, Narbonne, Bordeaux, Angers, Dreux, London, and Winchester in all probability.[240] None of these places looks at all promising, and we should surely look to his native Spain. It is significant (and amusing) to note that the horoscope was cast according to the *Standard* method, rather than his own, for we have conjectured that he changed over round about 1154.[241] He was born in Tudela (true latitude 42;04°). Barcelona looks much more promising (41;21°), and even more so Tarragona (41;05°), but this is pure speculation. We have at least found a tenuous link between the MS Laud fragments and Abraham, if only in the form of a preference for latitude.

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[234] Bodleian Library, MS Digby 51, f. 130 for the first. No reference is given for the second.

[235] Ff. 1r–2v. For a long Latin text associated with it, see Lipton (1978), pp. 221 ff.).

[236] Bibl. Nat., Paris, MS Lat 16208, f. 1v, with a text (Lipton (1978), pp. 221 ff.)

[237] Roger of Hoveden (Stubbs ed., 1868–71), pp. 292–3. Cf. Haskins (1927), pp. 127–8, and Lipton (1978), n. 30, pp. 224–5.

[238] See p. 16–17 above.

The figure of the nativity discussed here is the only one of which I am aware that can be reasonably ascribed to Abraham ibn Ezra, but there are many others that have been ascribed to him in the past, on the grounds that they are to be found in the work *De nativitatibus* first printed under his name by Erhard Ratdolt at Venice, on 24 December 1484.[242] Walter Koch, who thought that Abraham had been in possession of Regiomontanus's 'rational' method, pointed out with surprise that the example he examined (the first) was calculated according to the method of Alchabitius, rather than the rational method or the method of Campanus.[243] This is in fact true of *all* of the fourteen horoscopes in the printed work, although several of them are carelessly calculated, or printed, or both. The fact that they are illustrative of the text, and seem to be well integrated with it, is what leads one to suppose that either they belong to Abraham, or that the text itself is spurious. I can see no strong reasons for the second assumption, although I have not looked closely into the question. The *De nativitatibus* is not the same as the *In re iudiciali opera* (to take the name used in the first printing, at Venice in 1507, by Peter Liechtenstein) translated by Peter of Abano, nor is it the *Liber de nativitatibus* translated by Loys de Langle;[244] but there are manuscript versions older than the printed book, and one at least seems to be of the fourteenth century. None of the earlier versions has the horoscopes. The fourteenth-century manuscript, Digby 212, offers valuable testimony to the early association of the Ratdolt *De nativitatibus* with other works under Abraham ibn Ezra's name, some of them unquestionably part of the Abraham ibn Ezra canon.[245] The question of authenticity is one that the horoscopes cannot solve, for as I shall show, they stem from the very time of the printing of the book.

Before considering them in detail, and proving this point, another manuscript must be put into context. MS Digby 48 has a fine copy of the text between ff.116r and 143v, and while one would probably judge the hand to be of the early fifteenth century, this does have a full complement of fourteen horoscopes. It is followed, though, by the writings of Henry Bate that Ratdolt printed after the *De nativitatibus,* and when we reach the end of those writings we come across what is more or less the colophon of the printed book, date and all, 'non exemplaribus figuris singulis domibus ante positis'.[246] It is hardly surprising, therefore, that this (English) manuscript agrees so closely in its readings with the Venice printing, even down to the occasional inversion of arabic numerals (with '81' in place of '18', for instance). For what the observation is worth, the Cologne edition of 1537, 'restored' by Johann Eichmann (Johannes Dryander), leaves even the most obvious mistakes in the horoscopes unchanged.[247] As for the style in which the horoscope squares are drawn, this is the well worn style (e), but with a picture-frame, border, as it were, in which some information is held. There are two differences, one trivial – the absence of divisions in the border – and one fundamental. The 'picture-frame' pattern, if we ignore the cèntre square which could turn it into a triple horoscope, was originally one that was meant to accommodate a *double* horoscope. The example reproduced in Fig. 21, be it noted, was from a Jewish context – the Cairo Geniza in Abraham's own century. In the Ratdolt printing, the border is now used to record the house cusps for an ordinary, single, horoscope. In the Cologne printing, the frame is kept but shaded in, and all information

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[239] Burnett (1985), p. 290.

[240] Millás (1949), p. 290.

[241] See p. 23–5 above.

[242] The author is given as Abraham Judaeus and the date as M.ccc.lxxxv. nonas Kalendas Ianuarii. The work is accompanied there by Henry Bate's *Magistralis compositio astrolabii* and *Descriptio instrumenti pro equatione planetarum*.

[243] Koch and Knappich (1959–60), part 2, p. 74.

[244] I follow here the listing of Thorndike (1944), esp. p. 297.

[245] There are eight texts in the group in this MS. Ours comes at ff. 30r–33v, inc. 'Hic incipit . . . Dixit quoque Abraham Judeus, optimum instrumentorum ad inveniendum . . .'. The group continues at f. 34r (with Abraham's Introductorius) and ends with the MS at f. 71v (with his *Liber questionum*). British Library MS Sloane 312 associates our text with two other Abraham works, one of them not in MS Digby 212.

Horoscopes in the Ratdolt edition of Abraham ibn Ezra's *De nativitatibus*

	fol. (MS)	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Ven.	Mer.	Moon	Caput
A	118r	256	277	301	326	4	42	244	259	237	253 255	282	241	157	167[a]
B	118v	248	269	293	318	356	34	as above							
C	121r	264	280	316	343	19	54	351	20	272	198[b]	157	145[a]	343[b]	—
D	125r	176	199	229	243	279	16	218	247	61	345	303	4	107	—
E	128r	263	288	314	342	17	52	26	42[b]	158	—	—	338	67	—
F	129v	302	338	20	60	88	101	235	245	47	317	271	307	92	—
G	131v	235	255	274	294	333	15	247	266	—	289	323	272	197[b]	—
H	132v	275	303	335	18	48	70	245	261	245	266	295	243	278	—
J	135v	264	287	315	342	18	53	239	248	78[a]	19[b]	—	20[b]	199	—
K	137v	288[c]	322	359	38	62	86	241	263	220	231	253	249	200	
L	138r	259	291	307	333	11	47	233	239	153	135	132	135	—	—
M	139v	337	19	59	97	116	136	240	249	65	351	311	8	182	—
N	141v	77	105	137	170	201	231	237	241	36	291	244[d]	265[e]	206	—
O	142v	184	233	252	271	309	358 350	303	262	337	301[f]	244[b]	317	43[g]	—

Notes:

a. These values correct a peculiar error in the manuscript and book, where the arabic numerals are inverted – thus in the first case as '71 Virgo' rather than '17 Virgo'.

b. These are especially dubious readings, for reasons that need not be rehearsed here.

c. Corrected from 278 (MS and printed book agree).

d. and e. In the MS and printed book, both values are marked with the Venus symbol. The Cologne edition of 1537 follows blindly this and similar mistakes.

f. and g. Both are marked with the Moon symbol.

Where two readings are given, the printed book's is the lower, and takes precedence.

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[246] See f. 155r.

[247] Printed by Eucharius Cervicorum. On more than one occasion I have seen it stated that Cologne is a mistake for Marburg. In fact the same printer, in the same year (1537), printed Dryander's *Artznei unnd Practicir Büchlein*, and some copies bear the name of Marburg, others Cologne.

has been pushed back into the usual places. I have a feeling that the Ratdolt edition was rather influential in sixteenth-century horoscope design, but the matter is a trivial one.

The fourteen figures in the printed edition are abstracted in the table following below, where they are lettered from A to O. Although the first is called 'figura Ptholomei', this does not imply that it has anything to do with Ptolemy's time, but that it is done according to his principles. It is in fact contrasted with B, which has the same planetary positions, but which is described as 'figura Indorum', and which gives the cusps as the standard longitudes (in this case those of horoscope A) all *reduced systematically by 8 degrees.* This procedure bears comparison with the 'Ptolemaic', which results in a shift of 5 degrees in the first house (for which see sections I.17, II.1, etc., above).

Since these horoscopes are illustrative of the text, one might imagine that they were not meant to correspond with any actual, historical, configuration of the heavens, but one simple observation suggests otherwise: excluding C, E, and O, Saturn is never more than 22° removed from 237°, and excluding C and E, Jupiter is never more than 14° from 252°. Strangely enough, these two key regions in which the slowest moving planets were to be found are where the planets were around the years 1129 and 1130, but none of the other planets can be easily fitted except in the crudest possible ways during those years. The next time in history that the planetary positions fit at all closely is in the late fifteenth-century, when indeed the fit is excellent. Except in the cases of E, and N, where the Moon's position is poor, and allowing for one or two silent corrections that have been made on the basis of an obviously misrepresented zodiacal sign here and there, the following dates are all reliable to within a day or two at the most:

A — 28.11.1485
B — as in A
C — 01.10.1465
D — 24.02.1485
E — 1469 ?? (if so, very corrupt)
F — 26.01.1485
G — 31.12.1485
H — 08.12.1485
J — 26.03.1485
K — 04.11.1485
L — 29.07.1485
M — 01.03.1485
N — 31.12.1484
O — 10.01.1462.

It is quite clear, therefore, that the horoscopes were being cast at the time the material was being prepared for the press, and had a planned topicality, *applying as they did to the first year after the book's publication.*

One may learn more from the horoscopes, by analysing their implicit latitudes. For this purpose it is as well that we have the above dates in mind, for they suggest that we divide the horoscopes into two classes, and there is some support for this division in the derived latitudes. We should first dismiss O, which is a classic example of an unusable instance, with its cardinal points too close to the critical values of 180° and 270°. I also dismiss H and J, because they are each too corrupt to be restored by a single altered reading. B is ignored for reasons that should be obvious. Noting the similarities and differences on comparing E and J, one cannot avoid the thought that an astrolabe was used. If not, and the latitudes are all alike, the calculation was erratic. The derived latitudes are as follows (taking the obliquity as 23;33,30° purely arbitrarily).

A	51.10°	C	53.40°
D	48.38	E	51.36
F	47.24		
G	48.90		

K	47.51
L	50.77
M	48.19
N	51.15

We notice, first, how a change of a degree in λ_1 and λ_{10} as between C and E has made an appreciable difference to the derived latitudes – a warning, if any were needed, of the dangers of taking data rounded to degrees (see section I.7 above, on the range of uncertainty). We might well have associated C and E, purely on the basis of the proximity of the cusps, and the dates derived for them show that they fall outside the more interesting group for 1485. (N could just as well be for the first moment of 1485, and this would make all but three examples fall within the year following the publication of the book.) They could conceivably be connected with the nativity of someone connected with the printer, a young German of about nineteen – certainly not Ratdolt himself.

As for the other, larger, group, we know that taken individually the latitudes are unreliable, but statistically viewed they are of interest. The mean of the above left-hand list is 49.16° (49.09°), with a standard deviation of 1.62° (1;37°). The latitude usually assumed for Augsburg, 48;20°, falls well within the range of uncertainty here, and it seems highly probable that the Venice printer Erhard Ratdolt, who hailed from Augsburg, was having his place of origin commemorated in this singularly obscure way. Of course there is a much more prosaic explanation, namely that he brought a set of Augsburg tables with him to Venice, or that one of his assistants brought a table of houses for a similar latitude from the Bavarian area.

I leave the twelfth century with two observations. First, we have found from it no evidence for the *use* of any other than the Standard method (1), and this despite Abraham's texts, and despite Roger of Hereford's description of the method that was to go down in history as due to Campanus. We have of course very few horoscopes by which to judge the traditions of the time, but those we have do suggest a strong reliance on rote, and therefore on standard tables. It was simply unfortunate, viewed astrologically, that the standard tables in circulation covered so few latitudes.

This state of affairs did not change suddenly, by any means.

II.10. *The siege of Lucca (1261). Two horoscopes by Guido Bonatti*

If Dante is to be believed, Guido Bonatti is now in the eighth circle of the Inferno, condemned to look ever backwards, since in life he tried to probe the mysteries of the future.[248] His *Liber introductorius* was in fact the most comprehensive treatise on astrology written in Latin in his century, although inevitably it, too, looks backwards to numerous earlier authorities whose mutual inconsistencies would have been a better reason for putting him in the eighth circle. We have seen (section II.3) how he took material from Zael and Albumasar. On the mathematical principles of drawing up the horoscope he had little to say – which is odd, considering how comprehensive was his work. He said that the division of the cardinal arcs was well explained by Thebit 'in introductorio suo de spera celesti'. He knew Ptolemy's rule for the 5° shift in the limits of the houses, but does not say whether he intends to adopt it.[249]

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[248] *Inferno*, canto xx. Guido is named at line 118.

[249] I rely on the Bodleian copy in MS Savile 15, ff. 229r–362, inc. 'Anima est nobilius quod . . .'

Guido Bonatti was an astrologer in the employ of Guido of Montefeltro, and is said to have 'directed his master's military expeditions from a campanile with the precision of a fire alarm: first bell, to arms; second, to horse; third, off to battle'.[250] This, however, was towards the end of his life, perhaps from 1275 to 1283. In 1277 he completed his *Introductorius*, and dedicated it to his nephew.[251] The two horoscopes of interest to us by virtue of their originality belong to a period of Bonatti's life when he was in the household of Guido Novello, another notorious Ghibelline – Manfredi's vicar in Florence. He seems to have joined Guido Novello in 1260.[252] (Manfredi was the natural son of the Emperor Frederick II, and Bonatti is said to have been even earlier in the Emperor's train. There is much uncertainty here.) Accepting that he was a student at Bologna in 1233,[253] we may suppose that he was born within a year or two of 1215.

Strife between the Guelph party and the Ghibellines took a significant turn in July of 1258, with the expulsion of the Ghibellines (including the Guidi) from Florence. In May 1260, open war broke out between the Florentine Guelphs and the exiled Ghibellines, allied with the Sienese, in whose city most of them had earlier taken refuge. After initial reverses in 1260, the alliance defeated the Florentine Guelphs (at the battle of Montaperti, 4 September), who left their city and took refuge in Lucca (13 September and after). In September 1261 Guido Novello led the Tuscan Ghibellines into the Lucchese territory, and captured a number of strongholds. There was an unsuccessful attempt to capture Fucecchio, held by the exiled Guelphs. This is the background to the horoscopes.[254] They are reported here as they are found in MS Savile 15 in the Bodleian Library, with variant readings from folios t1r and t2v of the edition *Decem tractatus astronomiae* issued by Erhard Ratdolt, Augsburg, 1491 – with Johannes Engel as the editor.

		λ_{10}	λ_{11}	λ_{12}	λ_{1}	λ_{2}	λ_{3}
A	f.269r	174	298	224	244	279	313
B	f.269v	170	194	221	242	277	310

	Sat.	Jup.	Mars	Sun	Ven.	Mer.	Moon	Cap.	p.f.
A	13R	282	163	176	167	169	21	193	89
B	9R	286	182	205	203	216	41	182	78

Variant readings: (A) Jupiter 283, Mercury 167; (A and B) Caput and Cauda Draconis interchanged.

The houses are here equated according to the Standard method, and not particularly well, although the cardinal longitudes are acceptable. These give latitudes of 44;51° (A) and 43;27° (B), with a range of about two degrees of uncertainty. The details hardly matter, since we are told the place to which the horoscopes belong, namely Lucca, for which we know the latitude to be about 43;53°. It is not improbable that Guido used tables for the sixth clima (latitude 45;22°, according to the Toledan tables, and 45;01° for Ptolemy). As for the planetary longitudes, they are well calculated, and sufficient to give us dates of 12 September 1261 for A and 11 October 1261 for B – neither subject to an uncertainty of more or less a day.

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[250] Haskins (1927), p. 258; from Boncompangi (1851).

[251] Vasina (1970), p. 669, says 1276, but Bonatti mentions the battle of Valbona (1277).

[252] Ibid.

[253] Ibid.

[254] This brief chronology is drawn from a very comprehensive table covering the period 1140 to 1321, viz., Toynbee (1968), Table XXXI.

Guido Bonatti tells us of the circumstances surrounding the casting of the horoscopes. They both come in that part of his book that tells of the properties of the houses – and both come under the section dealing with the seventh house. The first was to help answer the question whether there would be a battle or not; the second to say, of a town or city, besieged or to be besieged, whether it would be taken or not. Specifically, the occasion of the first was 'when Count Guido Novello was in power in Florence, and we were with the army in the neighbourhood of Lucca'. Would the armies engage in battle or not? Bonatti judged it would happen, and so it did, for although at first the Florentines would not engage, later they went forth 'as is explained in the chapter on the besieged fortress'. There Bonatti explains how he was asked in the siege of a Lucchese fortress whether it would be taken, and he was able to give a favourable answer, based on his skill in astro-meteorology. (He foretold storms even though it had not rained for four months.)

In adition to these examples of his personal expertise – and here, of course, I have passed over his interpretative skills in silence – and over and above the borrowings from Zael and Alchabitius, Guido Bonatti included another horoscope in the *Introductorius* that clearly did not originate with him:

C	f.258v	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
		75	105	135	175;15	205	235

Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon
10;15	38;15	77;30	27;30	335;30	24;50	56;15

I can see no date that fits the planetary data well. The cusps of the houses are notable as a rare example from the middle ages of the use of the *Single Longitude method* of equating the houses. It is quite obvious that the 15 minutes of arc included in λ_1 were meant to be added to all the cusp longitudes alike.

II.11. *The Toledan tradition, especially in English manuscripts*

The very phrase 'Toledan tables' is misleading, since most of the tables in the collections so described did not originate in Toledo. We saw many instances of eclecticism and inconsistency in this connection, in Part I; and when we come to consider tables of houses, we must remember that they, like tables of rising times, are latitude dependent, and therefore do not travel well. The extent to which they were modified, as they should have been, but were often not, for use in new latitudes, is something that would repay detailed study. It would at the very least reflect on the awareness of astronomers of what, precisely, they were supposed to be doing. In the present section I shall confine my attention to a few simple developments, for the most part English, loosely connected with the Toledan tables. We have already spoken of their hesitant introduction into England in the twelfth century; despite the advent of the Alfonsine replacement for them in the 1320s – as far as northern Europe is concerned – the older collection had a faithful audience in some quarters even into the fifteenth century, although this was dwindling by the mid-fourteenth. The Bodleian MS Digby 68 tells us something of fourteenth-century attitudes: it contains a mixture of tables from both sets, and some others, with very little by way of an apparent pattern. The problem of consistency does not seem to have been uppermost in anyone's mind. To give an idea of how even the basic corpus of tables mixes its sources, and at the same time to summarize the material relevant to our theme that will be found in that corpus, I append the following scheme. The notations T_1 to T_5 have been used before and T_6 to T_8 are used here for the first time. Unless otherwise stated, the independent (first) variable is tabulated to integer degrees, and the dependent to minutes. The numbers in square brackets are the numbers allocated to the tables in G. J. Toomer's *A Survey of the Toledan Tables.*[255]

T_1 ($\lambda, \alpha + 90°$), parallel with tab. of equation of days. Implicit $\varepsilon = 23;35°$. [17]
T_2 (λ_1, α_0) and T_3 (λ_{sun}, D/12) for $\varepsilon = 39;54°$ (Toledo). Implicit $\varepsilon = 23;33,30°$. [18]
The same, for $\phi = 45°$ (Cremona). Implicit $\varepsilon = 23;51°$ (?) [19]
The same, for $\phi = 16°, 24°, 30°, 36°, 41°, 45;22°$, and $48°$ (Climates I to VII inclusive). [20 to 26]
The same, for $\phi = 50°$. Implicit $\varepsilon = 23;35°$. Perhaps for northern France generally. [27]
T_6 (λ, Sin λ) parallel with T_7 (λ, δ). Norm of the Sine: 150′. Implicit in T_7 is $\varepsilon = 23;51°$. Sine given to thirds, declination to seconds. [12]
T_6 (θ, Sin θ). Norm: 60°. The angle to half degrees, the sine to seconds. [13]
T_7 (λ, δ). To seconds. Implicit $\varepsilon = 23;33,30°$. [14]
T_8 (a, 12cot a). Shadow table, found in al-Khwārizmī, al-Battānī, etc. [15]
T_5 ($\lambda_1, \frac{25}{2} \tan \delta$). For ascensional difference by a universal procedure. See p. 14 above. [16]
Tables of houses already compared, as A and B, on pp. 16–17 above.

In addition to these moderately standard tables, Toomer lists one of type T_2 (λ_1, α_0) for Le Mans, with $\varepsilon = 23;35°$ and for a latitude of 47;56°.[256]

The Toledan tables masqueraded under other names in Europe. They were adapted slightly to Marseilles at much the same time (c.1140) and Toulouse, where they were modified none too successfully to be used with the Christian (rather than Islamic) calendar, and Roger of Hereford cited the Toulouse version in connection with his tables of 1178. He was aware of the source of the latter, though, and mentioned the work of 'the Toledans', as well as referring to some tables as by Arzachel. I have already discussed some of Roger's work on rising times and unequal hours, and his use of tables of hours as well as the astrolabe for the casting of the houses. For all his expertise, he seems to have been content to use a horoscope to illustrate his work that was evidently borrowed from elsewhere. From its ascendent (195°) and mid-heaven (108°) we deduce a latitude of a little under 44°, which could be Toulouse or Marseilles, but is about four degrees too high for Toledo.[257] Roger referred also to the London tables of his century, those we have already mentioned as having in their introduction a date of 1149. They do not seem to have been associated with any new material of the sort we are considering here; the main problem their makers faced was the adaptation of planetary tables to new longitudes. This is essentially a question of time conventions. In the same connection it is perhaps worth quoting Roger on a problem raised here in Part I: he says that all the tables he has seen begin the day at the noon before the civil day begins, whereas the London tables begin at noon of the day in question (that civil day being taken to start at midnight).[258]

As an example of a (presumably) thirteenth-century astronomer who concerned himself with the problem of adapting the Toledan tables to other places – in his own case London – and who at the same time helped to promote the Standard method of house division, we have one Roger of Cotum. Although his work has been catalogued differently in different collections, putting together the three relevant manuscripts we can see that there is a single work involved, which we may simply call his *canons* (*tractatus canonum* in the Digby 168 copy of the second part).[259] They are interesting to the extent that they give a clear account of the methods of modifying tables, and thus of the rationale of the tables themselves. They even include a short astronomical dictionary. Ten short chapters deal with problems of rising times, unequal hours, obtaining the ascendent from observation, and so forth, ending with one on finding the cusps of the houses, and another on drawing up tables of the houses for your particular latitude. There is nothing remarkable here, but the evidence that the tradition was alive is welcome in a century that (as far as England is concerned) is remarkable poor in surviving specimens of horoscopes. Roger's dates are entirely unknown. The Laud MS dates from perhaps the mid-1270s, but Roger might be much earlier. He is called *frater* in the manuscripts, and if he was a Franciscan, then we must take 1224 as a *terminus ante quem non,* since the Franciscans arrived in England in the autumn of that year. His concern with London suggests that he was from there. 'Cotum' is perhaps derived from 'Cowton'. (There was a more famous Oxford master, Robert of Cowton, also a Franciscan, early in the fourteenth century.)

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[255] Toomer (1968).

[256] Ibid., p. 153, from Bodleian MS Savile 21, ff. 98 ff.

[257] Bodleian MSS Digby 38, f. 99r; e Musaeo 181, f. 31v; Selden supra 76, f. 17v. The context is that of a work by Roger on astrology and astronomy, to which I think we may assign the incipit 'Quoniam regulas artis astronomice . . .', but it has to be said that there is a morass of technical problems. The planetary positions were perhaps borrowed from a yet older source, since they do not seem to approximate to anything in the 12th cent.

[258] MS Digby 168, f. 70rb. This text begins at f. 69vb: 'Diversi astrologi per diversos annos . . .', and ends at f. 83v.

One of the key figures in the rapid growth of astronomical study in Oxford in the fourteenth century was John Maudith, whose tables were evidently put together in the period c.1310–16. I have shown elsewhere that the two versions of canons to those tables were probably composed, not by him, but by Richard of Wallingford.[260] Maudith – and the writer of the canons explains the system – used the universal method for finding ascensional differences that we have already encountered in connection with al-Khwārizmī's tables.[261] This is a significant fact, for as we shall see shortly, another astronomer later in the century, also most probably from Oxford, tried to develop an alternative universal method (i.e. for use at any latitude).

To give an idea of how John Maudith's not inconsiderable reputation rested on the very tables from the Toledan group that have a relevance to our present subject, I note here the tables that are to be found in his collection, with the designation in square brackets that I gave them in my edition of Richard of Wallingford's writings:

T_2 for latitude 51;50° (Oxford) – original [not numbered]
T_3 for the same latitude – original [T_3]

$$\left.\begin{array}{l} T_5\ [\mathrm{IV(ii)}] \\ T_6\ [\text{part of I}] \\ T_7\ [\mathrm{IV(iii)}] \\ T_8\ [\text{part of I} = \mathrm{IV(i)}] \end{array}\right\}\ \text{Toledan}$$

For completeness, I note here that the other tables were of chords, right and versed, and a star list with relevant numerical material. From an Oxford point of view, why astronomers were so grateful, needless to say, was that John Maudith had saved them a great deal of calculation. What is more, they would not have thought it necessary to revise – in the interests of consistency – this geometrical material when the Alfonsine tables came on the scene a few years later. (It is hard to say when Richard of Wallingford first took the Alfonsine tables into account, but this might have been as late as 1330, although they were undoubtedly known in England before 1320).

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[259] I take it that the work was meant to begin at 'Quelibet pars aliquota totius fractio . . .', ascribed in Cambridge Univ. MS Ii.1.13, ff. 80r–84v, anon. in Bodleian MS Laud misc. 644, ff. 213rb–218vb. The second part is in the latter MS at f. 216 vb. it is also in MS Digby 168, f. 65r–66r, where it begins 'Qui voluerit planetas equare seu eclipses . . .', ascribed. These two MSS have a marked physical resemblance.

[260] North (1976), vol. i, pp. 3–19.

[261] Ibid., pp. 12 ff. Cf. p. 14 above.

One final word about Roger of Hereford's text, as a carrier of information well into the fourteenth century in the Oxford circle. A St Albans manuscript containing many of Richard of Wallingford's writings, and copied c.1350, has a copy of 'Quoniam regulas artis astronomice . . .' that could well have been made from a copy he himself made in 1321.[262] A work perhaps wrongly attributed to Roger, in what is now MS Bodley 300, was given by one Master Yngham to Clare College, Cambridge, at about the time it was copied, in the mid-fifteenth century.[263] In the chapter (17) on ascensions there is an interpolation mentioning the tables of John Maudith, and their value for Oxford. There is a copy of the same work in MS Digby 168, without this interpolation, but it has been copied out at the foot of the page in a seventeenth-century hand![264]

II.12. *A nativity of the poet Richard of Fournival (1200), and a thirteenth-century commentator. Some mistaken Haly Abenragel attributions*

There is in MS Hertford College, Oxford, E4, ff. 159r-166r, a short tract with a horoscope not only interesting in its own right – its subject Richard of Fournival, after all, was once confused with Ovid – but possibly connecting with other, anonymous work in extant manuscripts. In the course of discussing it, I shall need to consider the odd way in which it is dated; and later I shall consider the dating of a comet, in a work by the same author, Peter of Limoges. The problem is that of a style of dating that threatens confusion over the designation of the year. I begin, therefore, with a remark about the common mistake of thinking that the custom of beginning the year on March 25 (the feast of the Annunciation) is the only alternative to more familiar January 1 convention. In fact, quite apart from commencements at Christmas day and certain dates in September, there is the disturbing *mos gallicanus* to be reckoned with, namely the custom of beginning the year at Easter. Although never common, it was introduced into the French chancery by Philip Augustus (1180–1223), supposedly to 'mark his conquest of the English possessions in France by the use of a style different from those which had been current in them'.[265] This is not a serious problem in January and February, where the two alternatives are clear, but might become serious in the neighbourhood of Easter, in French documents.

The tract in question begins 'In nomine Jesu Christi, presupposito quod nativitas . . .'. There is a title 'De nativitatibus cum expositione Petri de Lenovicis (*sic*)', and the focal point of the work is the figure of the nativity at f.160r, which may be summarized as follows:

λ_{10}	λ_{11}	λ_{12}	λ_{1}	λ_{2}	λ_{3}
81	110	141	173;06	205	234

Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon
355;14	264;33	201;04	203;33	236;56	203;06	34;53
355	263	201	204	240	208	348

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[262] Bodleian MS Ashmole 1796 has a note at f. 37r including the words 'tempore factionis huius operis . . . 1321 . . . .' The MS was largely copied from Richard of Wallingford's papers, as I showed in my edition.

[263] 'Diversi astrologi secundum diversos annos . . .', ff. 1–19v.

[264] See f. 77v.

[265] Poole (1934), p. 23.

The last line gives approximate actual position of the planets on 10 October 1201, a date that is somewhat obliquely explained in the following statement:

> Ex hoc arguo nativitatem fuisse annis Domini 1200, mensibus a Martio 7 et diebus 9 perfectis,

and this:

> Annis Domini 1200, 9 a Januario 9.15.26 ad medios dies ... ad medium diem civitatis Ambianis, cuius longitudo est graduum 40, minutorum 30 ab Occidente, latitudo vero graduum 49, minutorum 36, nativitas servi Dei gloriosi, cum laude Dei et eius adiutorio.

The statements occur in the same form in the Hertford College codex as in a Vatican manuscript, as Aleksander Birkenmajer discovered long ago.[266] The first indicates that the year 1200 is complete, as are nine days and seven months counting from March inclusive. (Inclusive counting is a standard medieval style.) The second statement, apart from giving the latitude (49;36°) and longitude (40;30° from the West) of Amiens, the birthplace of the subject, dates the nativity rather as did the first, except that nine months are counted as complete (by implication) from January, again inclusive. This is an odd mixture of conventions as to the beginning of the year, but not confusing, inasmuch as both are spelt out, albeit cryptically. But what of the '9.15.26'? We know that nine days are complete in October, and therefore it seems that we are intended to suppose the time to be 15^h26^m. It may be verified that the right ascension of the Sun (taking an obliquity of 23;33,30°, since the Toulouse tables were in use) exceeds that of mid-heaven by 121;34,51°, which means that in true local solar time it is 8^h06^m before noon, or 15^h54^m after the previous noon. The '15.26' is therefore the time from noon. The equation of time makes up the difference of 28^m – the tables of al-Khwārizmī would have set the value at a little over 33^m.

The houses are tolerably well equalized in right ascension, but would be much improved if the ascendent were set at 174;06° in place of 173;06° (making rising the day houses 31.46, 31.76, 31.17, and the rising night houses 28.56, 28.46, and 28.60 degrees in extent – just about as good as one can expect when quoting cusp longitudes to degrees). This is an object lesson in reconstructing an astronomer's intentions, however, for the new reading implies a latitude of nearly 62°, while the old strictly implies 51;34°, but subject to the usual uncertainties. (The range in ϕ by simply increasing or decreasing the 81° for mid-heaven by half a degree is 46;46° to 55;32°, taking in Amiens.)

The text accompanying the horoscope is in a tradition of astrological biography, where each event in a person's life is seen as the fulfilment of a destiny prefigured in the stars at the person's birth. Birkenmajer, who spent a considerable time in tracking down the various fragments of text and reconstructing their history, does not appear to have published much more than an autobiographical account of how he did so.[267] He began by linking the Vatican codex Regin. lat. 1261 with the Paris codex lat. 7320, and by conjecturing that the anonymous nativity in the former was by Richard of Fournival, glossed by Peter of Limoges. Richard was a canon of the cathedral at Amiens, and died before 1260. He was evidently proud of the fact that the ascendent at his birth was that at the foundation of his native town. The horoscope was done with some pains – 'nec sine labore'. As for Peter's commentary, Birkenmajer has found the autograph calculations relating to it in another Paris manuscript, lat. 16658. This contains the Toulouse tables that were used, and evidently has a note suggesting that Peter was writing at some time between 1267 and 1295 – an unfortunately wide range.[268]

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[266] Birkenmajer (1949), pp. 18–31. See n. 267 below.

[267] Birkenmajer shows that he was leaving publication of these documents to others. He died in 1967. For a list of his publications, many of them on Richard of Fournival, see Birkenmajer (1970), where the 1949 paper is repr. (vol. i, pp. 222–35).

The occasion of Birkenmajer's published account of his efforts to connect the various fragments of text was Thorndike's publication of a short work by Peter of Limoges on the comet of 1298 or 1299.[269] The comet is dated 'anno domino M°CC° nonagesimo octavo ante finem Ianuarii et toto Februario et aliiquot diebus Martii', which Thorndike rightly follows Pingré in interpreting as 1299, for the sort of reasons already explained – without prejudice to the question of whether an Annunciation year was accepted, or the *mos gallicana*. Peter of Limoges, canon of Evreux, was clearly active in astronomy in 1299 – he gave precise measurements of the comet's position – and indeed he seems to have lived until 1306.[270] It is conceivable, in view of these facts, that he was responsible for horoscopes in certain other manuscripts that I shall discuss after considering a tailpiece to the Peter of Limoges commentary in MS Hertford College.

At ff. 166v–171v there is material that one would imagine to be a part of the commentary – the catalogue took it to be so. This contains three other horoscopes, summarized in the table below. The first of them is noteworthy for the fact that much of the calculation is done to thirds of arc, and the ascendent is so quoted. This first nativity is verified by *animodar* (compare the second), and is said to be for 21 January 1389. Planetary information in all three fits with the same year, and I do not consider it here except to point out that it conveniently segregates the text. Peter of Limoges was obviously not responsible for these figures. But who was? With data given to thirds, we ought to be able to derive precise figures for the latitude. Those derived (for obliquity 23;33,30°) are quoted in the last column of the table.

fol.	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	ϕ
168r	115;12,48	141	169	198;20,51,23	233	263	54;36
168v	112;58	140;17	168;19	197;23,47	232;21	262;19	51;46
171v	121	147	175	203;13	238	269	52;00

It is tempting to link the first latitude with that in another horoscope in the same manuscript (see section II.13 below), namely that at f.131r., for 1308, at a little over 55° latitude. This would be a mistake. The truth is that, notwithstanding the ascendent given to thirds, ours is rather poorly calculated – added to which it belongs to the other two, and there is little doubt that Oxford tables were used for all three.

We now turn to two works that have been attributed to Haly Abenragel, but that at best contain ideas taken from his *magnum opus*, considered above in section II.5. The first of these opens with 'In prologo theorice Ptholomei que dicitur Almagesti . . .', and is in whole or in part to be found in two Digby MSS, MS 97, ff. 94v–103v, and MS 114, ff. 199v–(229v).[271] The second begins 'Coniunctio est quando duo planete . . .', and is found following on the other tract in MS Digby 97, at ff. 104v–109r. It also comes in MS Digby 48, ff. 237r–242v, and in the Royal College of Physicians MS L.26, ff. 103v–104(?). Digby 48, with its bordered type of horoscope, has been discussed already, in connection with the

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[268] Birkenmajer (1949), p. 28.

[269] This is most conveniently studied in Thorndike (1950) ch. vii.

[270] Ibid., p. 197, n. 8.

[271] The latter version opens 'Dixit Aly filus Aben rachel laudatus sit deus qui est dominus subtilitatum . . .'. There are no horoscope figures.

Dryander printing of Abraham ibn Ezra (section II.9). The style is more or less – not precisely – the same in the present text. The problem that presents itself, in view of the consecutive nature of the texts in MS Digby 97, and in view of the fact that there we find twelve apparently homogeneous horoscopes running through the two works, is that of deciding whether the works really belong together.[272] In MS Digby 48, only the last eight of the horoscopes are to be found. Is there any continuity between the two sets of horoscopes, that is, the first four and the last eight? The question can be examined with the help of the following table, in which the contents of the twelve are summarized.

Of the twelve figures, only D of the first four has any comment at its centre, and provides a date (30 January 1297) and time (18^h complete – an approximate figure, from noon), the Sun being at 20° of Aquarius. Three of the second group are glossed:

F: Figura interrogacionis pro coniugio utrum perficiatur vel non.
G: Figura interrogacionis pro hereditate utrum querens habebit eam vel non.
K: Figura interrogacionis peregracione utrum compleat iter vel non.

The members of the second group are all for interrogations, and are explained in the text. They are unlike those of the first group, which are for a nativity, rectified by animodar.

The principal differences between the groups becomes clear as soon as we date them from their planetary longitudes. This is a more tedious matter than it would have been had the horoscopes not repeatedly misled us as to the intended signs in which the planets are located – an old problem. One cannot be absolutely certain that a sign has been lost or gained in the course of transmission: an error might be due rather to faulty calculation. In the table, I have indicated what seem to be errors of calculation by italicizing, and errors of sign by asterisks (some of which imply a shift of *two* signs). In selecting suitable dates, there is as always an element of personal preference involved: are we to represent the Sun as well as possible (since it was usually reasonably accurately known), or the Moon (which, moving much faster, might give us more precision), or should we aim to minimize statistically the deviations in some sort of weighted combination? I have generally aimed at fitting the Sun's position closely, and the dates offered might be a day or so removed from what the astronomer intended. What is abundantly clear, though, is that while A to D are for the 1290s, E to M lie very close together in the 1270s – in fact between 14 April 1276 and 5 July 1278. It is ironical, in fact, that these dates coincide with period of Étienne Tempier's condemnations of 219 erroneous propositions at the University of Paris (dated 7 March 1276, but using the *mos gallicanus*!), condemnations that were certainly not sympathetic to these interrogations.

The planetary positions in the two groups appear to be distinct, and yet the derived latitudes of place seem to have something in common. Here we meet the old problem with houses to integer degrees, and the only simple way round this is to find a mean value. This turns out to be 47;24° over the group of twelve, and 47;37° taking the last eight apart from the others. A French origin is virtually certain, and it seems to me extremely probable that the table of type $T_2(\lambda_1, \alpha_0)$ for the seventh clima, taken as on the latitude of Le Mans, and given in one manuscript as 47;56°, was in use in the construction of all these horoscopes.[273] It seems that John of Saxony was still using the table a generation later (section II.13 below).

The only reason for mentioning Haly Abenragel's name in connection with these

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[272] The style in MS Digby 97 is that which in section II.19 I suggest was a Merton College favourite, namely style (c) of Fig. 1.

[273] See p. 115 above.

		λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon	Caput	φ	
A	95v	75	103	135	168	199	229		Hse 12	Hse 12	Hse 2	Hse 2	Hse 2				
	—																
			105													presumed	47.46
B	96r	67	96	127	161	191	221	35	172;58	310;23	—	268	227;26	107;05	141;11	as C	
	—						220	33	173	321	226	273	230	104		1.11.1292	44.19
C	96v	75	103	135	168	199	229	25;16	147;08*	*137;09*	225;25	221;45*	213;28	*316;37*	141;22		
	—		105					33	173	320	225	271	227	79		30.10.1292	—
D	103v	237	257	277	297	336	6	103		294	320	297	303	165			
	—						16	103		294	320	276	297	165		31.01.1298	48.60
E	105r	322	34	63	110	128	151	218	33	*322*	331	320*	311	50			
	237r	352		73						*352*		350*	340*	*359*			
		352		73		129		217	39	251	331	288	323	49		11.02.1277	50.11
F	105v	192	216	255	292	310	331	218	28*	*42*	32	340	14	*20*			
	238r			237	255	292	331					348					
				237	255	292		214	52	296	32	349	29	152		14.04.1276	47.64
G	106r	349	30	69	105	126	147	220	45	284*	329	308*	345*	12			
	239r									314*							
								217	39	256	329	287	325	25		9.02.1277	46.73
H	106v	102	130	159	190	222	252	230	66*	132	110	136	118*	*130*			
	239r								96				119*				
								222	97	127	110	145	96	282		5.07.1278	44.16
J	107r	227	248	266	285	323	4	192	49	*5*	144	130*	147	*49*			
	239v													*39*			
								201	45	138	144	181	139	122		9.08.1276	48.48
K	107v	290	323	332	40	64	89	234*	50	—	179	226	222*	*144*			
	240v											228					
								205	45		179	223	199	247		14.09.1276	45.88
L	108r	192	216	237	255	292	331	225	*218*	16*	215*	188*	227R	*329*			
	241r										245	198*		*359*			
								222	77	346	245	254	238D	147		19.11.1277	47.64
M	108v	64	94	126	160	189	217	230	*46*	*272*	74	89*	87	*59*			
	241v				150								83				
					160			211	62	319	74	39	95	10		28.05.1277	50.29
																(mean)	47.41

Notes Opposite each horoscope, the first line gives the folio reference and readings to be found in MS Digby 97, the second line the references and variant readings (only) from MS Digby 48, and the third line some suggested emendations of cusp longitudes together with approximate planetary longitudes on the dates recorded in the end column.

An asterisk indicates that it seems probable that the figure recorded has been allowed to drift by 30° (in some cases perhaps 60°) in the course of drafting the horoscope. Italicised data are those for which no such shift can reasonably explain the poor figure.

opuscula, which may or may not be by a single writer, of course, is that he is named in the title to the first, as is Ptolemy – both because they were quoted as authorities. There must have been many Parisian masters capable of this sort of exercise in the 1270s and 1290s, and Peter of Limoges is at least a possible candidate, but for the time being, nothing more.

As an appendix to this section, I draw attention to the fact that MS Digby 97 is one of a genre of codices that has the nature of a collector's album of horoscopes. I shall later (section II.16) call upon its Alfonsine materials. Bearing in mind that the hand in the manuscript is generally of the fourteenth century, it is interesting to see how a fifteenth-century hand has added horoscopes to empty spaces, and how he or another writer has used the end-leaf for information (but with a square) on the nativity of his wife, Agnes, on 20 April 1432. The interpolated horoscopes are six in number. They all contain planetary information. I shall not give the material here in full – the houses, apart from two ascendents, are only to integer degrees – but rather introduce here a notation which will come in useful for the *indexing of horoscopes* by their cusp longitudes. I use six digits, the first three for the longitude of the ascendent to degrees only, the last three for that of mid-heaven. If one or more cusps is quoted to minutes I add 'm', and if to seconds an 's', and if thirds, a 't'. The nativity of Richard of Fournival will thus be written: 173081m. (Note the need to fill up with zeros. I shall later index horoscopes also by their Saturn and Jupiter positions, so that the same horoscope will then be: 355264m.) With this convention, the six horoscopes (which come at ff. 144v and 32r) are as follows.

(197113) For the entry of the Sun into Aries, 1455 March 11, said to be at $7^h31^m48^s$ in 'diebus non equatis' and 7^h40^m 'equatis'.
(068303) For the entry of the Sun into Libra, 1455 September 11, at $7^h56^m55^s/8^h21^m11^s$.
(131022) Sun into Cancer, same year.
(175084) Sun into Capricorn, same year.
(106346m) Nativity of J. Sutton, 1452 November 25, 6^h30^m . . . (etc.).
(027126m) The fortune of the father in relation to the previous nativity; the same day, a few hours different.

Emden lists two John Suttons of about the right age, one a prior of the Carmelite convent at Doncaster (can MS Savile 15 really not have come from Doncaster?), the other a fellow of Magdalen College, Oxford, and later of Eton. The latitude inclines us to the second. The last figure testifies to the continuation of a habit we met in the horoscopes of the Cairo Geniza. The group as a whole is compatible with a latitude of 51;50° or 51;30° (Oxford or London). Ignoring the fourth (note the uncertainty in view of the ascendent's proximity to 180°) we find 51;45° as the mean of five derived latitudes. Needless to say, all these horoscopes follow the Standard method still. Regiomontanus was not to rock the boat until a generation later.

II.13. *Alfonsine canons by John of Lignères, and a specimen calculation*

The fact that it is relatively easy to summarize procedures for domification using modern notations should not hide the difficulty many scholars must have experienced when carrying them out in the absence of a full table of houses for the assumed latitude. To give an idea of this, I here reproduce a very summary translation of no. 37 of a collection of worked examples, seemingly produced by John of Saxony in 1355[274] to illustrate the 37th chapter of canons written by his master, John of Lignères, for the Alfonsine tables.[275]

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[274] 'Quia plures astrologorum diversos libros . . .' I use the copy in Bibl. Nat., Paris, MS Lat 7281, f. 222r-. Chapter 37 comes at f. 230r.

> *To equate the twelve houses.* Example: I take an ascendent of 28;29,21 Capric. and a mid-heaven of 27;40,19° Sco. The right ascension of the latter is 325;22,30°. I enter the table of oblique ascensions for latitude 48° [Paris] with the ascendent, and take out the figure of 10;49°. The proportional part to be added is 0;01,28°, making 10;50,28°. I double this, getting 21;40,56°. Note here that the parts of an hour may be known otherwise, and with greater certainty. . . . Example: the right ascension for the given ascendent is as before. The right ascension of the descendent point is 95;45,08° from which I shall subtract the right ascension of the ascendent adding 360°. The remainder is 130;22,38°, which is the total diurnal arc, half of which will be 65;11,19°. Reduced to seconds: 234619. Divided by 3, that is in the quotient 78226, which reduces to 21;43,46°, which are the parts of a duplicate hour. I add it to the right ascension of mid-heaven, yielding 347;06,16, which is the right ascension of the eleventh house. Adding it again, to the latter, I get 8;50,02° for the ascension of the twelfth house, after subtracting 360°. Repeating the addition, the ascendent's right ascension is given, namely 30;33,48°. Subtracting the parts of a duplicate hour from 60° gives 38;16,14°, which is the nocturnal ascensional arc of the first three houses. Adding it to the ascension of the first house gives 68;50,02° as the right ascension of the beginning of the second. Repeating the addition gives 107;06,16° as the beginning of the third house. I then reduce the right ascensions of the houses by means of the table of right ascensions [as in another chapter, explaining the inverse use of the table], and I find 18;03,33° Sag. as the beginning of the eleventh house of the zodiac. Similarly, I find 8;06,30° Capric. for the twelfth and 28;25,31° Capric. for the first, which does not agree with the earlier figure of 28;29,20° Capric. I shall similarly reduce the ascensions of the other houses, yielding 7;06,24° Pisc. for the second and 18;33,21° Ari. for the third.[276] The cusps of the other houses are the nadirs of the first six.

The first point of interest in all this is that the tables of right ascension used by John of Saxony gave not α but α + 90°, a fact which is of no consequence when one is taking differences, and converting back and forth. The second point of note, after the computations have been checked, is that the table of right ascensions is for the old norm of 23;33,30°. It even appears that John was still obliged to use the old Toledan table for the seventh clima, the latitude of Le Mans (48°, put at 47;56° in one manuscript). The conventional and acceptable figure for Paris was 48;50°, and it is surprising that nothing more appropriate came to hand. There is in the thirteenth-century Bodleian MS Canon. misc. 556, at f. 51r, a table of houses 'ex astrolabio sumpte' for the latitude of Paris, given as 48°. This gives the houses only to degrees, and is of mediocre quality, inevitably. It would hardly have satisfied a mid-fourteenth-century John of Saxony. Although from an Italian collection, the provenance is French, of course.

John of Saxony wrote a set of canons of his own for the Alfonsine tables (inc.: 'Tempus est mensura motus, ut dicit Aristotelis . . .'), and they became extremely popular, especially after they were printed (at Venice in 1483, and often subsequently), together with a Parisian recension of the tables. This distinction was never accorded to the canons by John of Lignères. It is a curious fact that when John of Saxony came to ascensional problems in his canons, he threw in the sponge: '. . . qua habita, pars zodiaci existens in ortu invenitur per tabulas de ascensionibus signorum vel per astrolabium, et hoc declarare esset nimis longum'.[277] Perhaps my earlier assessment of what would have satisfied John of Saxony was mistaken.

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[275] John of Lignères' work (1322 or 1323, with incipit 'Cuiuslibet arcus propositi sinum rectum invenire . . .') comes earlier in the same codex. It includes the relevant chapter 37 (*Duodecim domos adequare*) at f. 185r, following standard explanations on ascensions and unequal (seasonal) hours). On these works see North (1977), p. 297, item 9, and p. 299, item 30.

[276] The last two numbers are dubious, since my microfilm is imperfect.

In the Bodleian manuscript Digby 97, discussed in another connection in the last section, there is an example of a horoscope in which – as in one of the examples from Hertford College MS E4, for 1389 – there is a use of sexagesimal thirds of arc; but now all cusps are so quoted, and not simply the ascendent.[278] There is a date provided (1356 January $2^{d}14^{h}18^{m}32^{s}$), for the purposes of finding the ascendent, though there are other calculations for 1356 (= 1355 complete). That the example is carefully calculated may be seen from the following longitudes and the right ascensions derived from them, expressed like their differences, the extents of the houses in right ascension, in decimal fractions of a degree:

House:	λ	α	diff.
10	144;14,17,08	146.57	23.85
11	169;33,49,05	170.42	23.87
12	195;31,28,10	194.29	23.84
1	220;34,17,08	218.13	36.16
2	255;32,18,17	254.29	36.30
3	289;00,00,00	290.59	35.98

The Standard Method is in use. The extents of the houses in right ascension, which provide a test of the accuracy of the original calculations, are not free from errors, but are much more consistent than most, whether from the fourteenth or any other century. Applying our usual methods, it seems that the latitude adopted in the calculation was 49;36° (= 23;33,30°) – not the latitude of Paris, but running across the map at roughly the level of Rouen, Luxembourg, Nürnberg. It is not a standard clima. I have seen Trier given as 49;40° and Reims as 49;20°, both of which fall within the range of uncertainty (49;14° to 49;45°) if we take the working to be accurate to a minute of arc. In the text itself there is mention of Paris in connection only with the fact that an adjustment for longitude is needed when using Paris tables at another place. It is all rather inconclusive, but we can at least say that there is no overwhelming reason for supposing the examples for 1356 (also found in B. N. Paris MSS Lat.7407, ff. 1r–26v and 15104, ff. 122r–137r) to be by John of Saxony himself. There is an interesting note on these calculations in Paris MS Lat. 7281, f. 222r ('Canones cum exemplis particularibus ad longum "Non fuit mortuus qui scientiam vivificavit etc." ponuntur exempla in omnibus canonibus super Christi 1355 completi et super Parisius'),[279] but we now see that whatever the author of this note might have thought, there is reason for doubting a completely *consistent* Parisian basis.

A few pages later in the same Oxford manuscript there comes a nativity for someone born on 10 March 1333 (the current year), with some astrological interpretations.[280] This occurs in another Oxford manuscript, namely Hertford College E4, ff. 126r–30v, to which

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[277] John of Saxony (Poulle ed., 1984), p. 50 (cap. xi).

[278] At 275v, perhaps misplaced – the other working for the same year comes around f. 242r. This is a related text 'Non fuit mortuus . . .'

[279] For this, and some valuable corrections to the over-enthusiastic hypotheses of Duhem and Thorndike on John of Saxony's biography, see E. Poulle's art. on him in DSB, vol. 7 (1973), pp. 139–41.

[280] At f. 288r.

I have already referred. In view of this fact, Lynn Thorndike ascribed it to John of Saxony, but again there is no reason for the attribution, even though there is a curious link with him.[281] We first note how the text opens:

> Investigacionis gradus ascendentis nativitatis est duplex modus. Prius est per locum alumptam super locum coniunctionis vel prevencionis que precessit nativitatem; secundus modus est per locum Lune in hora conceptionis . . .

The first method is given to Alchabitius, and we saw in an earlier section (II.4) that there are several puzzling horoscopes, dated as far apart as 1331 and 1391, associated with a version of the commentary on Alchabitius by John of Saxony. Although their implicit latitudes might be Parisian, they are generally outside John's lifetime. Here, in the 'Investigacionis . . .' text, the matter is still more clearly cut: the houses in the first horoscope (A, below, at f. 129r in the MS) are well calculated as for an Oxford latitude of 51;50° (actually derived: 51,54°), while those in the second (B, at f. 131r) are well calculated for a latitude in the neighbourhood of 54°, which I shall consider more closely later. They both have the planetary positions calculated on the basis of the Alfonsine tables. The Hertford copy gives the latitude of A as 52°, and the longitude of the place as 3° east of Paris – which is what gives the nativity the appearance of having had a Parisian author, no doubt. It is probable that the author was simply basing his geographical statement on a list with longitudes normed on Paris. He might have had a place in the region of Utrecht or Arnhem in mind – longitudes are notoriously unreliable. Whatever the intention, the cusps fairly certainly come from an Oxford table with a 'Toledan' obliquity implicit in it. One might argue for John of Saxony as author by spinning a yarn round the reference to 'Johannes Danekow de Magdeborch' in MS Berlin F.246 (anno 1458), f. 121r. Magdeburg is at a latitude of 52;08°, but fourteenth century references to it place it at 52;30°, and (approx.) 5° east of Paris. The easiest way with these facts is simply to drop the John of Saxony association, especially in view of horoscope B.

Here, then, are the houses, with right ascensions to the same norm as before:

A:	House	λ	α	diff.
	10	29;53,27	27.78	37.19
	11	66;50,05	64.98	37.05
	12	101;03,00	102.03	37.10
	1	136;39,07	139.13	22.63
	2	160;13,15	161.76	23.17
	3	185;22,21	184.93	22.86
B:	10	193;38	192.53	18.23
	11	213;00	210.76	18.27
	12	231;29	229.03	19.20
	1	249;54	248.24	40.76
	2	287;31	289.00	41.72
	3	328;33	330.72	41.81

The case of B is one offering an easy exercise in equalizing the houses in right ascension. The twelfth house is roughly a degree too large, and the first house a degree too small, judging by the adjacent houses. Changing λ_1 to 248;54° (i.e. assuming a mis-reading) results in a value of 247.17° for α_1, and revised extensions of 18.14° and 41.83° for houses 12 and 1 respectively – thus giving an excellent result. Recalculating, we get an even larger figure, namely 55;13,31°, in place of 54;17,51°. We do seem to be dealing with a person born, as the text has it, at a latitude of '55 gr. aliquantulum ultra'.

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[281] Thorndike (1923–58), vol. iii, p. 267. He found another occurrence in MS Vienna Nat. Bibl. 5296, ff. 23r–25r, other parts of which, I note, have English associations.

Places near this latitude are Newcastle upon Tyne, a few minutes below 55°, Tynemouth, nearby, and Newminster, at about 55;02°, where there was a house of Cistercian monks, known at least in the fifteenth century for astronomical activity. Alnwick is nearer the values derived – almost exactly 54;17°, in fact; and there were several university scholars of this name, although I have not found one who was born in the right year. The positions of the planets give the natal date as 18 March 1308 (soon after midnight). Further northwards, there is a string of places on the Tweed from which scholars might have come to Oxford. All told, the chances of locating a subject are as slim as those of finding the man born on 10 March 1333, the subject of A.

II.14. *Universal tables ascribed to John Walter*

The great disadvantage of a typical table of houses is that it holds good only for a particular latitude. The same is true for tables of ascensional differences and tables of oblique ascensions, themselves used in computing the houses in individual cases, or, on the part of an industrious astronomer, whole tables of houses. We recall that the ascensional arc ($90° + \alpha_1 - \alpha_0$) is divided into three equal parts at an important stage of the calculation. We saw in Part I, and were reminded in connection with the Toledan tables and John Maudith's use of them, that the canons to al-Khwārizmī's tables introduced a procedure for determining the ascensional difference for *any* geographical latitude.[282] Recapitulating briefly the steps in the procedure there recommended: the required quantity is given by the equation

$$\alpha_1 - \alpha_0 = \text{arc sin }([\frac{25}{2}\tan\delta].[\frac{12}{150}\tan\phi]).$$

The contents of the first square bracket are found as a function of λ_1, in what I have called table T_5, while those of the second, the umbra versa of ϕ, are found once and for all for a particular latitude, from a shadow table such as that we called T_8 in connection with the Toledan group. The required difference ($\alpha_1 - \alpha_0$) is not found immediately, but by using a sine table inversely.

It seems very probable that an English astronomer of the fourteenth or fifteenth centuries, no doubt familiar with the method here outlined through the work of John Maudith, was trying to improve on the procedure when he drafted the tables and canons for universal use now to be found in Cambridge University MS Ee.3.61. One authority for introducing the name of John Walter is Lewys of Caerleon, the late fifteenth-century astronomer and mathematician who had the distinction of being imprisoned by Richard III. Lewis was sceptical about John Walter's authorship, even so, and was only reporting a tradition that he had somehow come by. John was a fellow of New College, Oxford, by 1386, and resigned in 1393.[283] Lewis's scepticism extended, quite properly, to the merit of the table and the validity of the method associated with it. In the fourteenth-century

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[282] See pp. 11–14 and 116 above.

[283] See Emden (1957–9), p. 1972.

Bodleian MS Rawlinson D.238, the (dual) table is ascribed to John Walter,[284] but this can only be true of a part of it, as we shall see.

The canon is not the clearest example of its kind, and without the tables would be barely intelligible. It speaks of '*diversitas ascensionum*', for example, by which the author means a table of a *new type*, to which I give the abbreviation T_9 (λ,Sin α). The sines are to a standard radius of 60 parts. The phrase '*minuta proportionalia*' used of this sine was obviously chosen because the sine was to be used as a multiplier. Table T_9 seems to have been badly calculated, or badly copied, or both. The canon instructs us to use *another new table* (T_{10}) for the quantity $(M-180^\circ)/2$, where M is the longest day (in degrees), given as a function of latitude. We have seen in Part I that this quantity is equal to

$$\arcsin(\tan\varepsilon \tan\phi).$$

Now our old equation (5), rewritten for present purposes, amounts to this:

$$(\alpha_1 - \alpha_0) = \arcsin\left[\left(\frac{\operatorname{Sin}\alpha_1}{60}\right).(\tan\varepsilon\tan\phi)\right].$$

By his instructions in the canon, however, the astronomer shows that he means us to form the product

$$\left(\frac{\operatorname{Sin}\alpha_1}{60}\right).\arcsin(\tan\varepsilon\tan\phi),$$

wrongly supposing that this is equal to $(\alpha_1 - \alpha_0)$. One may sympathize with anyone restricted to purely verbal algebra; and there must in history be many without this disadvantage who have supposed that arc sin pq = p arc sin q.

In a final step we are told to subtract what he supposes to be $(\alpha_1 - \alpha_0)$ from α_1. (A short qualification to the rule is simply to take care of what we should describe as the changing algebraic sign of the function.) This was meant to provide the oblique ascension α_0, which is of course $\alpha_{10} + 90^\circ$.

In MS Ee.3.61 the canon comes at f.46v, while at 47r come the tables with this pithy comment at their head, by Lewis:

> Tabula diversitatis ascensionis figurarum pro omni terra habitabili secundum declinacionem Almeonis, et dicitur esse tabula M. Johannis Walteri, sed tamen certus sum quod non potest esse vera, propter difformitatem augmenti et decrementi ascensionis singulorum in circulo obliquo; sed errat hec regula in latitudine 52 graduum per 26 min. Conceptio tamen est laudabilis, quia per hanc viam possumus devenire ad gradum in omni regione ascendentem per altitudinem poli notam ut inferius declarabo et cetera. LEWYS.

These comments are well chosen. He is certain that the work is not John Walter's 'on account of the increase and decrease of the ascension of individual [degrees] of the ecliptic', by which I take it that he thought John Walter too astute to have drawn up a table lacking the correct symmetry.[285] When Lewis noted further that the table was according to Almeon's value of the obliquity ('*secundum declinacionem Almeonis*'), he was alluding to a tradition associating the name with an obliquity of 23;33° or 23;33,30°.[286] We recall that there are two versions of T_7 (λ, δ) in the Toledan tables, one with the latter obliquity, one with the Ptolemaic, rounded to 23;51°. The first 'John Walter' table in the Lewis manuscript is, as it happens, not alone: there is another copy at f. 120v, where this table of type T_9 is mingled with a table T_7 of 'Almeon' type. The latter is far from accurate – some of its entries are shifted by a place, which might explain in part the deficiencies in the table that interests us, T_9. Lewis's remark that 'the rule is in error by 26′ at a latitude of 52°,' was made in relation to a calculation for a now unidentifiable ascendent.[287] Despite everything, he was rightly prepared to concede that the conception of the rule was laudable!

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[284] At f. 2r. See Thorndike and Kibre (1963), col. 720 for others.

[285] Complementary values of λ_1 (say λ and λ') should come opposite entries sin α and sin α' such that sin α = cos α'.

[286] For some of the British tradition on this point, see North (1976), vol. ii, p. 185 and vol. iii, p. 256.

The second table, to which we gave the abbreviation T_{10}, for 'the semi-excess of the longest day over the equinoctial day' (in degrees and minutes) as a function of the latitude of place, at half degree intervals of ϕ from 0;30° to 60°, quite certainly does not use 'Almeon's' obliquity, but rather 23;35°. There is yet another copy of this table T_{10} at f. 120v, but there the half-degree values of ϕ are omitted below 13;30°. These tables T_{10} are of a much higher quality than T_9, and one wonders whether a futile attempt was made to modify T_9 to correct for palpable mistakes in the end-results of actual calculations. This seems quite likely, but there is little point in setting out long specimens of arguments for apparent adjustment. It is all very uncertain. Suffice it to say that calculations based on the supposed John Walter tables yield houses maximally differing in ascensional extent by less than a degree at English latitudes, but by more at higher latitudes.

II.15. *John Walter's conventionl tables*

Whatever the truth of the ascription to John Walter of the universal method of the last section, there are more conventional tables associated with his name. These, with canons beginning 'Volenti [igitur mihi] operari per tabulam completam domorum . . .', survive in perhaps eight manuscripts, in slightly variant forms.[288] Here I follow the canons as found in British Library MS Egerton 889, ff. 69v–70r, and the tables of Bodleian Library MS Rawlinson D.238, ff. 2r–25v.

The first important difference between the universal procedure and the conventional method advocated by John Walter is that in the former we were told to begin with the *ascendent*, in the latter with *mid-heaven*. (In a later section we shall see that John's close contemporary Nicholas of Lynn used the ascendent convention, unlike that of his own (conventional) tables.) This might be taken as an argument reinforcing Lewis's doubts about the correctness of the ascription of the universal tables, but the argument is much weakened when, at the end of the present canons, we find John explaining a 'subtler' method than that using his tables, and now beginning with the *ascendent*. It is of course nothing more than an explanation of the fundamental principles of the Standard method.

For convenience, I denote the conventional tables by W_1, W_2, and so forth; we recall that the universal tables are T_9 with T_7, followed by T_{10}. The conventional tables may now be briefly described:

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[287] The curve in the error in $60' \sin\alpha_1$ is double peaked, with a maximum at a longitude of about 30°, a minimum at about 60°, and another (lesser) maximum at about 75°. At 45° the error is 29′. (Here we are covering only the first quadrant, namely $\alpha_1 = 0°$ to $90°$).

[288] Without atempting to list the various forms, I note examples in Oxford, Magdalen College MS 182 [c. anno 1483], ff. 45ra,51rb; Bodleian Library, MS Laud misc. 674 [15th cent.], ff. 20r–23r; MS Bodley 432, ff. 39r–44v; MS Digby 97, ff. 43r–53v; British Library, MS Royal 12.D.vi, ff. 81r–(84v) and MS Sloane 407, ff. Of these, the tables in MS Digby are fine. See Thorndike and Kibre (1963), cols 104, 720, and 1708.

W_1: A table of *houses* (ff. 2r–7v in the Rawlinson MS), the form of which is shown by the beginning of the first and last rows of numbers in the first component table, that for an ascendent in Capricorn. The method in use is of course Standard:

Cap.	10				11			12			1		[etc.]
grad. zod.	ascens.		[equacio] dierum		Cap.		dre.	Aqu.		dre.	Aries		dre.
	g	m	g	m	g	m	m	g	m	m	g	m	m
1	1	6	3	41	29	23	44	[0]	7	30	3	8	44
					Pisc.			Aries			Gem.]		
30	32	13	0	41	10	22	48	23	22	48	3	17	44
λ_{10}	α_{10}		Δ		λ_{11}		d	λ_{12}		d	λ_1		d

The meanings of the various columns are shown by the notations below them. The equation of days, Δ, is the difference between mean and apparent time as a function of solar longitude.[289] As explained in the canons, these differences have to be taken into account 'since the tables of the planets are drawn up in *mean*, i.e. equal, days, but the hour for a question or nativity is taken by a sundial [*horologium*] or some instrument or other [giving apparent, i.e. true, solar time]', John admits having borrowed 'old tables' since new ones were not available, but thought the old ones accurate enough. One would dearly like to have cross-examined him on this question of accuracy and consistency, in the astrological context, not to say the astronomical.

W_2: A table of *longest daylight* for various geographical latitudes (1° to 13° by 1°; 13;30° to 66;30° by 0;30°, but 60;30° to the end not completed in any MS). This is table T_{10} in the less complete versions mentioned earlier. It is based on an obliquity of 23;35°, as we may see most easily from the figure opposite $\phi = 45°$ (when $\sin 25;53° = \tan \varepsilon = \tan 23;34,59°$). Some specimen values:

Altitudo poli(ϕ)	1;00	30;00	45;00	51;30	2;00	52;30
Medietas addicionis diei longioris	0;26	14;37	25;53	33;20	34;01	34;43

W_3: A table for *atthazir*. As explained, this is for 'the place, and any sort of aspect according to the projection of rays atthazir, or directions of degrees by the ascensions of signs in individual houses'. This is not of relevance to our theme. There is further material on aspects, also apparently by John Walter, in a work beginning 'In unum collecta . . .' following the present tables in the present MS (and found elsewhere), bearing a date 1404.

W_4: A table of *solar declination* of Toledan type T_7 placed as in the universal tables *in parallel with the table* T_9 (λ, Sin α). This might be taken to indicate that John Walter was indeed the author of the universal method.

A section of the canons not so far mentioned explains how the whole process of domification is to be begun, namely from the true place of the Sun. This leads to its right ascension, α_s; its hour angle (in *equal* hours after the meridian) is assumed known, and added to α_s, this gives α_{10}. The table of right ascensions on the left of W_1, used inversely, with interpolation, gives λ_{10}, and the other houses. (The table on the left could, he explained later, be used to give the right ascensions of all the houses, if need be.) The columns of differences, d, are to help with interpolation; but John Walter noted that 'for ordinary questions and elections and other operations' it is enough to work to degrees. As we know from fourteenth and fifteenth century practice, astrologers were happy to follow his advice.

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[289] See Toomer (1968), pp. 34–5.

II.16. *A fifteenth-century 'table of houses' for Oxford*

The expression *tabula domorum* is capable of many interpretations. Another example, where the astronomer responsible has left the user with much work still to do, is in the Bodleian MS Digby 97, ending at f. 134r, and beginning at f. 131r with a text 'Si volueris componere tabulam ascensionum ad civitatem tuam, quere primo sinum rectum latitudinis . . .'. The first table that follows the text is of type T_7 (λ, δ), of Toledan type with obliquity 23;33,30°. To a norm of 150 minutes there is a parallel table of sines (T_6) and another to follow, to a norm of 60 parts. Tradition dies hard! In the 'table of houses' (ff. 133v-134r) there is no latitude or place stated. In combination with the didactic nature of the opening text, this suggests an academic exercise, a stage in an as yet unfinished procedure. Some specimen entries under Capricorn will give an idea of the form of the table:

	Med. diei	arc.	quantitas domus		altitudo merid.		quantitas diei	
	g	m	g	m	g	m	g	m
1	56	19	18	46	14	37	7	31
15	57	50	19	17	15	27	7	43
30	62	1	20	40	17	56	8	17

After the longitude on the left comes the semi-diurnal arc in degrees (right ascension), followed by one third part of this, namely the *extent* of a house, on the Standard method, in right ascension. The meridian altitude of the Sun, for the given longitude, is self explanatory, and the last column is simply the full diurnal arc converted to equal hours. There is nothing remarkable about this. It is hard to place the work in time. The hand seems to be of the first half of the fifteenth century. The meridian altitude of the Sun when its longitude is Libra 0° or Pisces 30° is given as 38;10°, the complement of the latitude of place. Oxford is therefore indicated ($\phi = 51;50°$). When the Sun is at the summer solstice, Gem. 30°, the meridian altitude is given as 61;43°. This exceeds the equinoctial value by 23;33°, which confirms that the given table T_7 was used for the 'table of houses'.

Without some other table (such as T_1 (λ, α)), the ordinary medieval astronomer would have been unable to cast the houses from this work, or indeed to have drawn up a table of oblique ascensions, to which end the text was directed.

II.17. *John Holbrook's table of oblique ascensions for Cambridge*

Among a number of other tables attributed to John Holbrook in MS Ee,3.61 (the Lewis of Caerleon collection with the universal tables) there is a table of oblique ascensions also said to have been his. Holbrook (d. 1437) was educated at Peterhouse, Cambridge, where he became a fellow in 1412 and master between 1418 and 1431, by which date he had twice been chancellor of the university. We shall meet him again, in connection with some horoscopes of Henry VI. The table in question (at f. 62r & v) is for the latitude of Cambridge, taken as 52;19°. This was a commonly accepted, but not very accurate, figure. (It is about six minutes of arc too high.)

The table, in addition to the columns for oblique ascension, contains columns for 'partes horarum duplicate', that is, the time equivalent (in minutes and seconds) of *half* an unequal hour. Referring to this quantity as h, expressed as a fraction of an hour, this means that $(2h - 1)\ 180° = \alpha - \alpha_0$. The two sets of columns could have been based on different values of the obliquity, but turn out to be based on 23;33,30°. Again, there is always – as we saw in Part I – a possibility that two values for ε are implicit in a table for α_0. If we pick out the value (a, say) opposite $\lambda = 90°$, this should not depend on the value of ε (say ε_1) used for the table of right ascensions, the reason being that the corresponding right ascension is 90° on *all* tables. We know then that

$$\tan \varepsilon_2 \tan \phi = \cos a.$$

For Holbrook, $a = 55;38°$ and $\phi = 52;19°$, yielding $\varepsilon_2 = 23;33,30°$, to the nearest second. This value is confirmed in general calculations on randomly chosen entries, and also in the column of half-hours.

The association of these tables with those others in the same manuscript for universal methods, namely the dubious 'John Walter' tables, leads one to wonder whether John Holbrook was responsible for the latter. The general resemblances between the conventional Walter tables and the universal tables, not to mention the fact that the latter seem to be based on $\varepsilon = 23;35°$, seems to render the hypothesis improbable. The association of these various tables within a single manuscript is probably due more to Lewis of Caerleon than to Holbrook; and Lewis was clearly not the author of the universal tables.

II.18. *Ascendents hour by hour. The influence of the clock on astrology*

The Bodleian manuscript Laud misc. 594 includes a number of astronomical tables, copied at various periods, mostly from the fifteenth century. The gathering between ff. 84 and 91 is somewhat earlier in style than the pages before and after it, and is in a late fourteenth-century, or possibly early fifteenth-century, hand, reminiscent of the hands of professional scribes used to calendar work. These leaves contain an unusual set of tables of the houses, of greater intrinsic interest than is at first evident. The set ends with a short and rather trivial canon, at f. 91r, headed 'Operacio', and beginning 'Primo invenias in almanak anni mensis ad diei . . .'. The tables are ostensibly of two different patterns, and these are illustrated here by the complete headings and some specimen entries from the first table of each sort (from ff. 84r and 90r respectively). The uncertain readings are a consequence of damage to the manuscript. I have introduced one new sort of abbreviation here, for the signs of the zodiac, which are, in sequence: A T G C L V L′ S S′ C′ A′ P. The correspondence should be obvious. 'Post meridiem' is denoted by 'p.m.' as usual, and 'post mediam noctem' by 'p.m.n.'.

We know that we can deduce the accepted value of the obliquity of the ecliptic from a knowledge of the accepted latitude and the longest day, quoted at $16^h29^m33^s$ (see equation (14) of Part I). This turns out to have been 23;33,30°, true to the nearest second with the data provided. Ths 'Toledan' value is hardly surprising, in view of the preferences of Oxford astronomers revealed in earlier sections. We note that the ascensions in the second column seem to be given in the tradition of $T_1'(\lambda, \alpha + 90°)$. This is again characteristic of

Tabula electionis temporum ad sciendum quis gradus ascendat in latitudine 51 graduum et 50 minutarum cuius modus (?) est universitas Oxonie, cuius hore equales in die artificiali longissimo sunt 16 hore 29 min. et 33 sec. Ascendat inquam ibidem in meridie et inicio cuiuslibet hore equalis diebus equatis inclinando (?) diem naturalem a meridie diei presentis. Et primo pro signo Arietis.

Grad. solis ipso sole existente in signo Arietis	Ascensio signi Arietis in circulo directo ad diem differentem sole in meridie existente.		Ascensio signi Arietis in circulo obliquo pro Oxonia corespondens ascensioni predicte.		Ascendens in Meridie diei	Ascendens prima hora p.m.	Ascendens secunda hora p.m.	Ascendens hora tercia	Ascendens hora quarta	Ascendens hora quinta	Ascendens hora sexta	Ascendens hora septima	Ascendens hora octava	Ascendens hora nona	Ascendens hora decima	Ascendens hora undecima	Ascendens in media nocte	Ascendens prima hora p.m.n.	Ascendens hora secunda	Ascendens hora tercia	Ascendens hora quarta	Ascendens hora quinta	Ascendens hora sexta	Ascendens hora septima	Ascendens hora octava	Ascendens hora nona	Ascendens hora decima	Ascendens hora undecima
					C	L	L	L	V	V	V	L′	L′	S	S	S	S′	S′	S′	C′	C′	A′	P	T	G	G	C	C
g	g	m	g	m	g	g	g	g	G	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g
1	88	40	0	25	26 L	7	18	28 V	9	19	29 L′	10	21	1	11	22	3	14	26 C′	10	28 A′	23 P	27 A	2	29 C	18	3	15
15	100	18	6	12	5	15	26 V	6	17	27 L′	8	18	29 S	9	20	30 S′	11	23 C′	7	24 A′	17 P	19 A	25 T	24 G	13	30 C	12	24 L
30	113	15	12	51	14	24	5	15	26	6	17	28	8	18	29	10	21	5	21	13	14	20	20	12	28	11	22	3

Tabula equacionis domorum ad meridiem Oxonie cuius latitudo est [etc.]

ARIES						TAURUS						GEMINI						[etc.]
Ascendens, id est prima domus	Secunda domus	Tercia domus	Quarta domus	Quinta domus	Sexta domus	Ascendens, id est prima domus	Secunda domus	Tercia domus	Quarta domus	Quinta domus	Sexta domus	Ascendens, id est prima domus	Secunda domus	Tercia domus	Quarta domus	Quinta domus	Sexta domus	
	T	G	C	C	L	T	T	G	C	L	V	G	G	C	C	V	E′	
	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	g	
1	3	3	1	30	29	1	26	18	14	16	24	1	20	10	30	9	22	
15	14	11	6	7	10	15	7	28	20	26	6	15	3	22	10	22	6	

the Toledan tables, although there the implicit value of ε is 23;35°. When we look more closely at the second column, however, we see that it is not quite what we expect. The first entry, for instance, has opposite a solar longitude of 1° a figure of slightly less than 90°, rather than slightly more. What is the explanation of this?

Consider the case when the Sun is at 30° longitude, and it is mid-day. The table tells us that the ascendent will be 134° (Leo 14°). One would expect – following tradition – that mid-heaven (λ_{10}) would be simply 30°. When we perform our own calculation of α_{10} based provisionally on $\varepsilon = 23;33,30°$ and $\phi = 51{:}50°$, however, we find a figure (27;53,21°) more than 4° in excess of the figure we might have expected, starting from the second column of the table. Again, looking at the problem conversely, what longitude should we expect to yield the 'right ascension' in the table (or rather 113;15° − 90°)? The answer, approximately 25;07°, is nearly 5° below what we look to be λ_{10}, for this case. Clearly the table is an unusual one.

Turning to the more transparent aspects of the tables, consider the astronomer's problem *ab initio*. We are to take the longitude of the Sun from our almanac (so the relatively uninformative canon says). Under the appropriate (equal) hour of the day we shall find the correct ascendent. The key to the construction of such a table is this: the *oblique* ascension on any line for a particular hour is 15° greater than that for the previous hour. Thus from the bottom line of the extract given here, the oblique ascension for 24° Leo should be 15° more than that for 14° Leo. The 24° entry could have been found, for instance, by using a later table of oblique ascensions to find the value opposite 14° Leo, adding 15°, and then searching for the result in the same table, i.e. using it inversely. This procedure seems to have been carried out in the table, accepting the third column at its face value, namely as a table of oblique ascensions for Oxford. It is indeed a well calculated table of ascensions, seemingly taken from John Maudith's of 1310 (even though the length of the longest day is given in the heading to one copy of the Maudith table as $16^h29^m36^s$, which is no doubt the result of miscopying).[290] The column on the extreme left is obviously not to be taken as the Sun's position, when we are extracting the oblique ascension; but the user of the tables has no need to use this third column in any case.

This is equally true of the second column; but that does not explain it. The astronomer needed *some* table of right ascensions in order to compute his second table, the table of houses. It is worth putting the second column to the test to see whether this was the one he used. Taking it as a table of $\alpha + 90°$, the third, for α_0, being equal to $\alpha_{10} + 90°$, their difference will give three times the size of one set of houses. For an ascendent 15° Taurus, for example, the size of the houses 10, 11, and 12 is 35;33°, following this procedure, while 1, 2, and 3 are then obviously 24;27°. In the first column opposite 15° Taurus is 127;08°, added to 24;27° giving 151;35°, which comes nearest in his table to 9° Gemini. But his table of houses gives 7° Gemini; and working back from his complete set we should estimate his houses as of 23° (approx.) in extent in right ascension. (A better figure would be close to 23;40°.) At all events, we too should estimate the second house as beginning at 7° Gemini. This is just one of many checks, showing that the author could not have used the second column as a simple column of right ascensions, with the first column as corresponding longitudes.

We are told in the caption that the second column is the ascension in the right circle 'ad diem differentem'. On a different day? If that is what is meant, it does not tell us very much. In fact I think it is much more ingenious than its cryptic rubric leads us to suppose. If the time is noon in mean time, *the Sun will not be on the meridian*. The first column of the first table gives us, we are told, the *true* place of the Sun, to which corresponds the ascendent at noon. The solar longitude is *not* identical with that of the cusp of the tenth house, or its right ascension with $\alpha_0 - 90°$. The treatment we offered in section I.18 was based on their supposed identity, simply because this crude assumption was made by almost all astronomers before the sixteenth century, and a large proportion after that. We saw John of Saxony making the assumption – and like so many others, he was capable of establishing the position of the heavens rather approximately, and then of finding the longitudes of the cusps of the houses to seconds of arc. If one were to make the necessary distinction between true (apparent) solar time and mean time, and regard the second as the datum, what would one do to discover the longitude of the culminating point of the ecliptic, that is, λ_{10}? Today we should seek out the equation of time. In the middle ages, one could have followed Ptolemy on this point, or al-Khwārizmī, or al-Battānī; and a good fourteenth-century example of an astronomer who showed his command of the theory of the 'equation of days', as it was called, was Richard of Wallingford in his treatise on the Albion.[291] This is how an astronomer of the time would probable have proceeded with the problem in hand:

> For each value of λ_s find the corresponding value of $\alpha_s + 90°$, or α_s, from a table of right ascensions. From a table of the equation of time, find the value of the equation corresponding to λ_s. Subtract E from α_s, giving α_{10}, that is, $\alpha_0 - 90°$. Using a table of oblique ascensions inversely, the ascendent may be found from α_0. And for the other houses proceed in the usual ways.

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[290] North (1976), vol. i, p.16, with reference to MS Laud misc. 674, f. 72r. Note that Maudith's tables ('verificata 1310') include a column 'quantitas domus'.

[291] North (1976), vol. i, *Tractatus albionis*, II.10; see the commentry in vol. ii, pp. 168–71.

To analyse the first of our new tables, therefore, we proceed thus: for each value of λ_s in the first column we take out the value of the noon ascendent (λ_1) from the fourth. (Unfortunately, this is rounded to the nearest degree, and only a statistical approach will be acceptable beyond this point.) Entering column 1 with this value of λ_1, we take out α_0 from column 3. From λ_s, we find the value of $\alpha_s + 90°$ from any table that seems likely to have been used by our author. There is nothing in the present set that will serve. For reasons to be explained, I have here used the relevant columns of the calendar of Nicholas of Lynn.[292] We can now take the differences between the values of the last two functions, namely α_0 ($= \alpha_{10} + 90°$) and $\alpha_s + 90°$, allowing us to tabulate and plot $\alpha_s - \alpha_{10}$ against λ_s. (Specimen values for $\lambda_s = 15°, 30°, \ldots 90°$, are 2;34°, 3;49°, 4;04°; 4;57°, 5;06°, 4;16°).

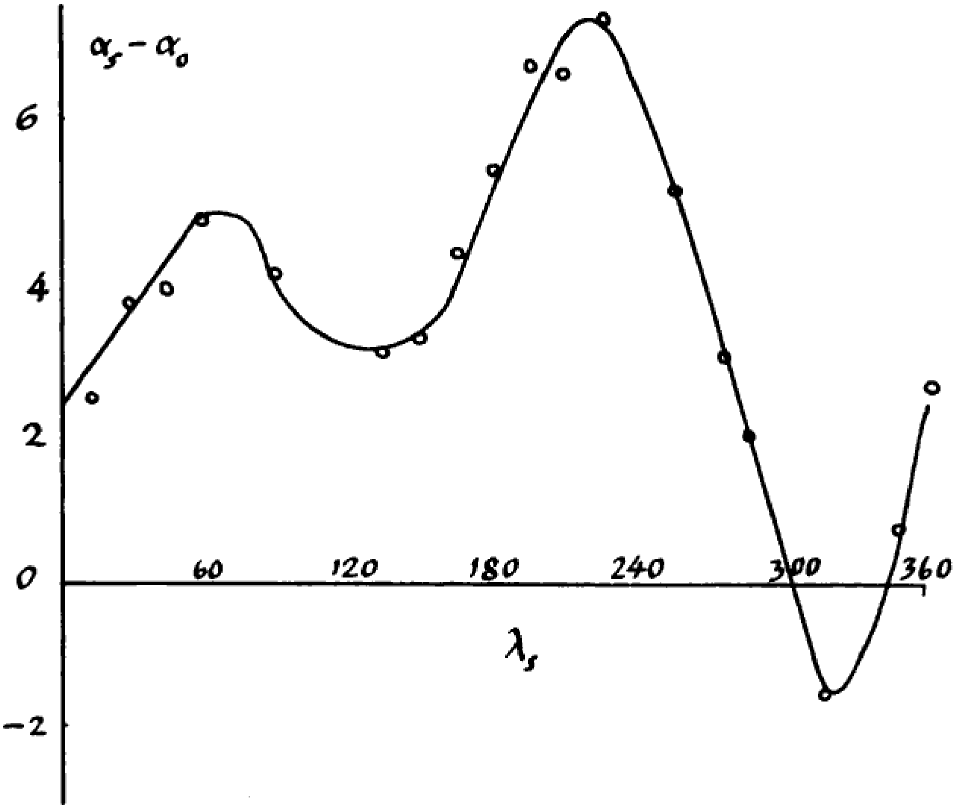

Fig. 23 A comparison of the curve obtained from al-Khwārizmī's equation of days with points plotted on the basis of a table of ascendents hour by hour, in a way explained in the text.

The results of performing this exercise are shown in the accompanying graph (Fig. 23). This completely confirms our suspicion that the astrologer means us to use equal hours, clock time. From the amplitude and phase of the graph, we can say with some certainty that a table based on al-Khwārizmī's, if not his, was in use. The double-peaked behaviour of the curve reflects, of course, the fact that the Sun's velocity varies over the course of the year, and that the true Sun is not moving in the equator (with respect to which mean time is measured). Statistical uncertainty apart, the curve we obtain is al-Khwārizmī's.

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[292] Nicholas of Lynn (Eisner ed., 1980), pp. 164 ff., second column.

The reason for thinking that Nicholas of Lynn's tables are relevant here is that he seems to be a very strong candidate for authorship of the tables under discussion. His calendar, with its unusual variety of tabulated astronomical material, was issued around 1386, and some of the copies are in manuscript style close to the tables of Laud misc. 594. He was not of course alone in correlating natural hours with hours of the clock, but he did in his calendar regularly refer to equal hours as hours of the clock, and whatever we may decide about their authorship, the Laud tables do seem to reveal the effects on astrology of the fourteenth-century revolution in timekeeping. An astrologer who had ears to hear the striking of a tower clock, or who had access to a clock, preferably with a dial, no longer had any need to make an observation of the heavens to fix the time of birth.

Nicholas of Lynn's calendar included the data of column 3 of our first table (oblique ascensions for Oxford) and exactly the same tables of houses as in our second table, apart from an occasional copying error. Was this freshly calculated, along the lines I indicated, or did he simply work from the more accurate table of houses of John Walter? (In the second case, it would seem that he had a preference for rounding *up* to the next higher degree.) Our author could of course have borrowed from Nicholas's calendar, or have rounded up John Walter's table of houses, if he was not identical with either man, but this would not have provided the table of ascendents hour by hour. One would have thought that an astrologer would have found this invaluable, and it is surprising that copies of the hour-by-hour tables are not more numerous.

The arguments for Nicholas of Lynn's authorship are not compelling, and there are several other Oxford candidates – we cannot locate the date of the tables even to half a century. The tables of houses to integral degrees, for instance, might be from even the first half of the fourteenth century. They seem to offer house divisions that are almost, but not quite, the same as those used in the horoscopes of a very numerous collection in MS Digby 176, discussed more fully in our following section (II.19). The Digby group does not suggest that those responsible were working to integral hours, or interpolating in our table I, but this is hard to say with any certainty. Here are two examples from the horoscopes in the Digby MS associated with John Ashenden's 'Significacio eclipsis lune':[293]

A. For a lunar eclipse on March $18^d 9^g 40^m$, 1345, by which is meant March 19 (18 days are complete). A contemporary calendar would have given about Aries 7° as the true place of the Sun (or a few minutes less). With this, the ascendent (following the table I) at 9 p.m. was Scor. 4°, and at 10 p.m. Scor. 15°. This does not quite square with the ascendent in the horoscope. The houses are: 149° (mid-heaven), 174°, 199°, 223° (ascendent), 259°, and 293°. If we accept the ascendent of 13° Scor., the houses in table II are all a degree or so removed from these, and changing the ascendent by a degree or two will not rectify the situation. Some other table was in use.

B. A minor conjunction of Jupiter and Mars on 1345 March 0^d 13^h 35^m. The Sun's true place is taken as 349;20°, and interpolating in the table I gives an ascendent in the neighbourhood of 14° Sagitt. (254°), the Sun being at 349° exactly, at $13^h 40^m$. This is near the $13^h 35^m$ of the horoscope; but taking that figure we could not have got 14° Sagitt. precisely, even with double interpolation (as between rows and columns), which is in principle called for. The table of houses (II) offers similar, but not precisely the same, cusps.

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[293] Beginning at f. 9r of MS Digby 176; the horoscopes come at ff. 11v and 14r (where the first is repeated in a different form), and are two of six.

In summary, it seems improbable that the tables of houses in MS Laud and Nicholas of Lynn were used in the 1345 horoscopes, or that use was made of table I from the former. This is evidence, albeit weak, for a *terminus ante quem non* for the Laud work.

II.19. *Horoscopes and the lord of the year*

MS Digby 176, introduced in the last section, may be used to illustrate a traditional astrological procedure calling for a horoscope. The precise moment of the entry of the Sun into Aries marks, of course, the beginning of the year. The interval between successive entries into Aries was called a revolution of the years of the world, *revolutio annorum mundi*, and there was a whole sub-species of literature dealing with the horoscope representing the heavens at the crucial moment of entry. There must have been more than a dozen texts in circulation in the West, of varying degrees of fame, and more than a hundred Arabic tracts, but the best known included Māshā'allāh's *De revolutione annorum mundi*, a work perhaps by Abū Ma^{c}shar with the same title, and others by Abraham ibn Ezra, Guido Bonatti, and several lesser Italian writers. The topic was commonly encountered in more general astronomical texts, but the doctrine was essentially the same in all contexts: the strengths of the planets were to be assessed at the entry of the Sun into Aries, and the most powerful (judging by its aspects and position in regard to the faces, terms, and planetary domiciles, not to say exaltations and dejections) was to be named lord of the year. The principles of assessing planetary power lie outside the scope of this book – there were commonly seven or more different criteria – but there was an important point of principle in Māshā'allāh's fifth chapter (following the divisions of the 1549 Nuremberg edition): one was to work from a horoscope drawn up for *one's own latitude*.

This was the context for the table in MS Digby 176 (ff. 22v–24r) giving the lords of the year from 1332 to 1386, listing the twelve houses for every year's beginning. It is perhaps worth noting that that pattern of the horoscopes throughout this manuscript is (c) of Fig. 1, a pattern much less common in western manuscripts than in Arabic sources. In view of the fact that MS Digby 176 is associated with several different hands, almost all of them however of Merton, we might suppose the pattern to have been favoured in that college in the fourteenth century. The codex has a very rich history, as the note on the verso of the first leaf tells us:

> Liber M. Willelmi Reed, episcopi Cicestrensis, cuius partem habuit ex dono Rev. Domini sui M. Nicholai de Sandwyco, partim emit de executoribus Rev. Patris Domini Thome de Bradewardina, archiepiscopi Cantuariensis, partem emit de executoribus M. Ricardi Camsale, partem ipse M. Willelmus scripsit, et partem scribi fecit . . . .

Its subsequent gift to Merton is recorded in this substantial bibliographical note. To the names already listed here, we may add Walter Merle, whose weather diary for 1337 begins at f. 4r, after a preamble at 3r ('Hec sunt consideranda . . .'); John Ashenden, responsible for several of the prognostications in the volume; and Reginald Lambourne, whose prognostications cover the period 1363 to 1374 – all of them Merton men.

There is a none too clear division between the ill-assorted pages written by Reed and the 'scholars', and those by professional hands, but while the neat eclipse and syzygy horoscopes seem to come into the second category, the material on lords of the year is probably in the first. It is interesting to see that there, rather than use a standard horoscope form, a tabular style was adopted, as indicated in the following transcript of the first line of the material (where I write 'Cancer 15 grad.' as '105', and so forth):[294]

Ascenciones

1^a dom.	2^a	3^a	4^a	5^a	6^a	7^a	8^a	9^a	10^a	11^a	12^a	Anni Christi	Domini Annorum
105	122	141	161 Moon 187 Sat. 163	205	246	285 Jup. 285	302	321	341 Mars 347 Sun 1 Ven. 1 Merc. 4	25	66	1332	4 Sun 3

It is easily verified that this follows the Standard division into houses, and for a latitude that is on the face of it around 53°. One is tempted to say that the calculation is badly done. For some reason I cannot explain, the houses after the first are all systematically 2° less than standard Oxford tables would have made them. This line of the table should be regarded as a separate form of horoscope: it is not so much a philatelic urge that drives me to say this, but that *it is important to recognize horoscopic material in other than the obvious square format.*

Squares in the style already mentioned (style (c)) occur throughout the section in which prognostications of the weather are made on the basis of celestial configurations during eclipses and syzygies. To this last section of the manuscript, as it now survives, belong some solar tables (ff. 71r). The earliest date is that of a conjunction of the Sun and Moon at Combe on 4 December 1317 at 5^h25^m. For this there is a horoscope done in the standard way ($\lambda_{10} = 340°$, $\lambda_1 = 103°$) and with planetary positions added. Another figure for Combe, also with planetary positions, and indeed a few computations, follows the first ($\lambda_{10} = 122°$, $\lambda_1 = 204°$). It is easily verified that these are compatible with an Oxford latitude (the full complements of houses are in our usual sequence 340, 24, 65, 103, 121, 139 in the former case and 122, 149, 176, 204, 239, 271, in the second), and yet the manuscript sets Combe at a latitude of 51;30° and a longitude of 13;30° from West. This does at least help to identify the Combe in question. Of the seven or eight possibilities, we can certainly rule out the Cistercian house between Rugby and Coventry and the village near Woodstock. Since Oxford was traditionally placed at latitude 51;50° and longitude 15;00°, and since this is an Oxford work, done by someone who ought at least to have known the topology of the neighbourhood, we should probably favour the hamlet south west of Newbury in Berkshire. Whether this can be turned to any biographical purpose I cannot say.

Horoscopes for the prognostication of the weather (*pronosticacio temporum*) based on syzygies were still being cast with high seriousness in the seventeenth century, as we shall see later.[295] Here, in MS Digby 176, we find tables of syzygies for every year between 1341 and 1346, inclusive, with a horoscope for each of them, done for Oxford in five years out of the six, the exception being 1342, where the exercise is for London. Again we have here an item of biographical relevance, but to an unknown subject. Can it have been William Reed himself? I record here the data from the first of the many horoscopes, that for the opposition of 3 January 1341, put at 5^h56^m p.m., and another from the London set (for 7 January 1342, now a conjunction):

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[294] The table is at ff. 22v–24r, and loosely connects with an earlier table at ff. 19r–21v, which gives the dignities of the planets for every month over the interval 1328–1357 inclusive (but not complete).

[295] Here one might do worse than follow up the reference in the opening words of a text coming earlier in MS Digby 176 (at f. 30r): 'Sicut dicit Haly secundo *Quadripartiti* Tholomei, cap. 6 . . .' This text goes naturally with the 'diary' I am discussing.

λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon
25	63	98	134	157	181	270	196	240	293	259	274	113
66	96	128	162	191	219	280	223	26	297	322	297	297

These houses are not well enough calculated to say whether there was indeed a difference between the principles used in the sheets for Oxford and London (see ff.95r–120r), but it is noteworthy that if we are dealing with prognostications, the author was probably already in London by the end of 1341, and planning to stay for 1342. Elsewhere in the volume there are solar tables (an almanac, in the medieval sense of the word) for the years 1341–4, and this was 'super meridiem Oxonie per W. Reed anno Christi 1337 calculata et scripta'. (The reasons offered by R. T. Gunther, following P. S. Allen, for saying that this is in Bredon's hand are not very convincing.)[296]

II.20. *English royal horoscopes in the late middle ages*

Horoscopes for individual nativities – as opposed to elections, interrogations, and revolutions – are relatively rare in medieval England. Even royal horoscopes are far from common. Those that survive may at least be seen as a measure of what was taken to be the best practice, and for this reason I shall look briefly at a score or so of examples, reserving the following section for a closer study of seven that are associated with Henry VI, and that have a special interest and unity of their own. Some of the essential details of the other examples are to be found in the following table. The numbering of the horoscopes follows that of a work by Dr Hilary Carey, in which much additional information will be found.[297] The abbreviations for manuscript references are those now widely known following the usage of Thorndike and Kibre (who did not, however, include Gloucester Cathedral).

It is important to realize that many, if not most, of the horoscopes in the table are retrospective. The manuscript containing 1, 3, and 5, for example, is of the fifteenth century. Woodstock is, of course, near Oxford (item 5), so it is not surprising that Oxford tables seem to have been used in the case of the Black Prince, but they were less appropriate to Caernarvon, and yet were very probably used for Edward II who was born there (item 1). Reducing mid-heaven by a degree would make Oxford tables fit the case of item 2. By the same token, item 3, for the same subject (Edward III) needs increasing by a degree in the figure for mid-heaven. It is not improbable that these horoscopes have been adjusted (badly) from Oxford tables, or indeed from other English tables. One cannot be sure, simply because they are calculated only to degrees. A time quoted with item 2 is noteworthy: $17^h43^m24^s$, the Sun's longitude being given as 238°. This comes very close to the figure one would obtain after performing an 'equation of time' calculation, for which see section I.16. There is further evidence of sophistication here: the birth was said to be 'in principio aurore', and it may be shown that with the figures provided, the altitude of the Sun was about 21° below the horizon, implying that dawn was indeed close. It was no doubt this fragment of information that led to the establishment of an ascendent.

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[296] Gunther (1923), p. 59.

[297] Carey (1984), esp. chapter 6, and the long appendix 3, in which the contents of the horoscopes are reproduced in detail.

English royal horoscopes, 1284–1470

	Date	Occasion	Place	True lat.	Derived lat.					MS ref.	
					Min.	Mean	Max	λ_1	λ_{10}		
1	25.04.1284	nat.Edw.II	Caernarvon	53;08°	50;48	51;12	52;04	106°	345°	BMr 12 F.17 f.153v	1
2	13.11.1312	nat.Edw.III	Windsor	51;29	51;15	52;05	53;47	216	140	ibid.	2
3	13.11.1312	nat.Edw.III	Windsor	51;29	48;02	50;06	50;54	216	138	BLas 192 f.109v	3
4	23.01.1327	cor.Edw.III	Westminster	51;30	51;15	51;38	52;20	78	312	BLr D.1227 f.2v	4
5	15.06.1330	nat.Black Pr.	Woodstock	51;52	50;37	51;47	54;32	156	58	BMr 12 F.17 f.153v	5
6	15.06.1330	nat.Black Pr.	Woodstock	51;52	47;48	49;17	52;43	159	63	BLas 192 f.110r	6
7	1.01.1367	related to 8	Bordeaux	44;50	51;22	52;24	53;03	320	[254]	BLr D.1227 f.1v	7
8	6.01.1367	nat.Ric.II	Bordeaux	44;50	51;24	51;48	52;29	76	310	ibid.	8
9	15.07.1377	cor.Ric.II	Westminster	51;30	50;55	52;44	56;55	165	70	ibid., f.2r	9
10	5.07.1376	qun.Ric.II	Westminster	51;30	49;10	51;25	52;26	167	73	ibid., f.2r	10
11	16.09.1386	nat.Hen.V	Monmouth	51;50	52;08	53;11	53;37	238	174	BLas 393 f.109r	11
12–15	5/6.12.1421	nat.Hen.VI	Windsor	51;29	(see G, A, E, and B in the following section)						12–15
16	18.04.1442	nat.Edw.IV	Rouen	49;26	52;26	52;44	52;55	333;33	260;07	Glouc.Cath.21 f.9v	16
17	2.11.1470	nat.Edw.V	Westminster	51;30	51;41	51;48	51;59	44;19	288;35	ibid.	17

The Ashmole MS 192 is a seventeenth-century copy of older material – the two nativities, in fact, having been copied by Elias Ashmole himself. The first (item 3) was copied from a window of a house occupied by Richard Bruerne (1491?–1565), canon of Windsor. That it shares the ascendent with item 2, also for Edward III, does not mean that it comes from the same source: the planetary positions and other details are appreciably different, yet it seems to me that both may be corrupt copies of the same original. The Black Prince's nativity (item 6) is said to have been from an old manuscript owned by Mag. Allen, fairly certainly Thomas Allen, of Gloucester Hall.

The five horoscopes from the Rawlinson manuscript (4, 7, 8, 9, 10) are on the flyleaves, and have an appearance of being contemporaneous with Richard II, or nearly so. We note that there are John Walter's tables in the same codex. Item 7 is a figure for the conjunction preceding the nativity of Richard II (item 8), and is thus being set up in order to rectify the time of birth by the doctrine of *animodar* (section I.17 above). Froissart, who was in Bordeaux when Richard was born, sets the birth at 'about ten o'clock', thus disagreeing with our astrologer to the tune of three hours.[298] The Toledan tables were seemingly in use for the general calculations, but the houses were emphatically cast according to an English latitude, well to the north of Bordeaux.

Judging by extant writings, the English court saw much less astrological activity than the French, and there appears to be no English nativity for the first Lancastrian king, Henry IV. There is a French figure for him, however, in one of two large collections of horoscopes discussed in general terms by Emmanuel Poulle. The horoscopes in these collections concern French and English notables, and are about eighty in all. They include such English subjects as the first three Lancastrian kings, the Duke of Bedford, the Earl of Salisbury, and Sir John Fastolf. War and dynastic uncertainties provided the motivation for this mammoth astrological effort. Of their astronomical quality, I have not been in a position to judge.[299]

The Ashmole 393 horoscope of Henry V (which is also found in MS Ashmole 192, in the hand of Sir George Wharton, Ashmole's friend) comes with a short tract, evidently composed in the king's lifetime.[300] As in all earlier royal nativities, the planetary positions were well calculated by the standards of the time, and now Henry had the inestimable advantage of having been born on the latitude of Oxford. Despite this fact, I would guess that a Cambridge table was in use. According to the colophon, the latitude of birth was 54°, which rather suggests that the scholar responsible thought that figure correct, and took Cambridge tables, as the more northerly of the pair most easily available. He certainly reveals none of that attention to fine detail that characterizes the horoscopes of the Cambridge satellites of Henry VI, as we shall see in the next section.

After the Henry VI items, the style changed. We now see the houses given to minutes of arc – as we saw them calculated in the time of Adelard of Bath! Throughout this entire period, be it noted, the horoscopes are calculated according to the *Standard* method. Although the nativities of Edward IV and Edward V (items 16 and 17) are from the same manuscript, they can hardly be by the same astronomer. Both have well calculated planetary positions, but the first is done on the basis of 'Norwich tables' ('secundum tabular Norwici', by Master John Argentine), quite inappropriate to a Rouen birth, while the second is for an Oxford latitude, plausible enough for a London birth, although the astronomers of Henry VI might have worried about the discrepancies. Argentine was

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[298] Ibid., p. 237.

[299] Poulle (1969).

[300] Carey (1984), p. 246.

Provost of King's College, Cambridge, and a royal physician, holding the former office between 1501 and his death in 1508. One court connection seems to have been as physician and chaplain to Arthur (1486–1502), son of Henry VII, from the time of the prince's birth.[301] Since Eward IV was dead by April 1483, and his unfortunate son by the following September, it seems likely, though, that the story by Domenico Mancini is correct, and that Argentine earlier served the young king in the Tower.[302] According to Neil Ker, MS Gloucester Cathedral 21 was written 'mostly by and partly, perhaps, for John Argentine', and it contains a number of choice astrological pieces, both Jewish and Arabic authors in translation, as well as several English authors. The codex contains, as it happens, the very tables of the houses that Argentine used for his nativity of Edward IV.

These tables 'for the latitude of Norwich' (stated as 52;42°) were prepared by William Norwich, a monk of the Benedictine Hospice of Horsham St Faith (true latitude 52;39°, about 0;05° north of Norwich). They are to minutes of arc, unlike the Norwich tables of a somewhat later date, discussed in section II.24, below; but both are alike drawn up to the Standard method.

With the spread of printing, royal horoscopes found a wider audience, and an international one, which we shall have occasion to consider in section, II.25. Cardan's horoscope for Edward VI became notorious; but Cardan also printed a nativity for Henry VIII.[303] Henry had been at Greenwich in 1491, but Cardan was an astrologer in a hurry who did not strictly need such information as to place: his houses were all of 30° exent – in short, he used the Single Longitude method. Later in the century, another collector of nativities of the famous, Johannes Garcaeus of Saxony, published a figure for Edward VI (11.10.1537, latitude 52;30° – in reality 12.10.1537, at Hampton Court, latitude 51;22°).[304] Published in 1576, this came at the high point of Regiomontanus's influence, and was based on his tables, but for quite another latitude (49;30°, it seems). This was an age of rapid and careless production for an untutored clientele, more interested in interpretation than in the accuracy of what was being interpreted. That this interest was very real can be judged from the large numbers of annotations made by the early owners of books in this genre.

II.21. *Animodar and attention to detail. Henry VI under a Cambridge spell*

Although there are several fragments with horoscopic material relating to the nativity and reign of Henry VI of England (1421–71), there is one valuable work collecting together most of the material. Whilst it has an axe to grind, on the question of interpretation, the computational materials it contains are what concern us here. The unique copy of this work is in the Cambridge University MS Ee.3.61, which we have already discussed in connection with universal methods for domification. It is in the hand of Lewis of Caerleon, begins 'Cum rerum motu et varietate sideree . . .' (f. 155r), and ends at f.171r with the note

> Completum est hoc opusculum anno domini M$^{\text{mo}}$CCCC$^{\text{o}}$XLI$^{\text{o}}$, xviii$^{\text{o}}$ die mensis Julii, magistris meis specialibus, magistro Joh. Somersett et magistro Joh. Langton, in vigilia assumpcionis beate Marie eodem anno mense Augusti in familia regis apud Shene per manus meas liberatum.

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[301] Talbot and Hammond (1965), pp. 112–5.

[302] Carey (1984), p. 303.

[303] See n. 325 below.

[304] See p. 160 below, for more information on Garcaeus' style.

It was evidently done by an unnamed author in the twentieth year of the king's life, and the eighteenth of his reign (he was born on 6 Dec. 1421 and his reign was taken to have begun on 1 Sept. 1422). Since the defection of Burgundy and the loss of Paris, the English cause in France had been recognized as desperate since the mid-1430s. Moved by simple-mindedness or spirituality, whichever way one may look at it, the king had involved himself with foundations at Eton and Cambridge from about 1439, helped by John Somerset,[305] a Cambridge master who was also his physician; and excitement at court in 1441 was stirred by the possibility of a marriage with a daughter of John IV, count of Armagnac – which, as it happened, was not to materialize. There was no question about the need for astrological counsel, and evidently no shortage of astrologers ready to provide it, if not to agree on its content.

There was another cause for excitement. In July 1441, Eleanor Cobham, Duchess of Gloucester, was accused with two clerks, Roger Bolingbroke and Thomas Southwell, as well as the Witch of Eye, Margery Jourdemayne, of conspiring to bring about the death of the king. The Duchess fled to sanctuary at Westminster; Southwell died in gaol; Bolingbroke was hanged, drawn, and quartered; and the Witch of Eye was burned as a relapsed heretic.[306] Astrology was not, as such, cited as a part of the crime, which concerned plotting the king's death by necromancy and the black arts, but the men were practised astrologers, and we shall have occasion to mention their work shortly. Southwell was in fact an Oxford graduate in medicine, and Bolingbroke principal of St Andrew's Hall in the same university. It was unfortunate that the horoscope they cast for the king could be taken as predicting his imminent death, and two of the king's trusted servants, John Langton and John Somerset, were directed to look into the question – with the result now known through the copy of the work made by Lewis[307] from a now anonymous original. (Somerset was a medical man, who must have had some astrological knowledge, but Langton, as a lawyer, probably had very little.)

The tract 'Cum rerum motu . . .' is a work timid in its positive assertion, but bold in its criticism of men who would, within a few months, be dead. These aspects of what is an interesting exercise in currying royal favour do not concern us here. There are, though, various figures drawn in the manuscript, and it will be useful to tabulate their contents at the outset. All are to pattern (e) of Fig. 1. These are the colophons to the horoscopes:

A. Figura nativitatis illustrissimi principis regis Henrici 6^{ti} anno Christi 1421 incompleto post meridiem sexti diei Decembrorum 3^h41^m. Arcus equacionis [no figure quoted].
B. Figura nativitatis H. 6^{ti} secundum Mag. J. Holbroke cuius archus ascen[sionis] est $44^g\,22^m$ et est cuiusque domus cuspis minutam proximam ad minutam scriptum in angulo.
C. Figure perfectionis anni 20^{mi}.
D. Figura revolucionis anni vicesimi a nativitate contingentis anno gratie 1440 post meridiem quinte diei decembrorum $18^h27^m33^s$.

The cusps of the houses, for these and additional horoscopes to be introduced shortly, are as follows:

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[305] Talbot and Hammond (1965), pp. 184–5.

[306] For more circumstantial detail see Carey (1984), chapter 7.

[307] Carey (1984) notes correctly that the work was not (as Pearl Kibre had supposed) written by Lewis of Caerleon, who was probably not even born in 1421.

	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	fol.	stated time p.m.
A	315;57	359;19	42;45	81;49	99;26	117;17	160r	3^h41^m
B	309;53	352;30	35;47	75;56	93;36	111;23	161v	
C	165;57	209;19	252;45	291;49	309;26	327;17	164r	
D	181	202	224	244	280	318	166r	$18^h27^m33^s$
E	[315;59]	359;31	43;08	82;25	99;47	117;28	160v–61r	
F	177	199	221	241	278	315	166r–6	
G	309;52	352;29	33;45	75;54	93;34	111;22		$3^h20^m56^s$

The positions of the planets are listed in the table opposite, where the number of the house in which each planet is to be found is given in parentheses after its longitude.

The supplementary horoscopes in these tables are:

E. The nativity cast by the condemned Roger Bolingbroke and Thomas Southwell, taken from 'Cum rerum motu . . .'.
F. An anonymous Oxford horoscope, from the same work. See below.
G. Another nativity for Henry VI, taken from MSS Ashmole 369, f.182v, and Egerton 889, f.5r. This has the colophon: Nativitas Henrici sexti anno Christi imperfecto 1421°, 5^a die Decembris post meridiem, $3^h20^m56^s$, die Veneris, hora Saturni. (Additional remarks are considered below.)[308]

It is obvious from the tract accompanying the new version (A) offered by the anonymous author that he was heavily dependent on John Holbrook's version (B). Holbrook had died in 1437. The later writer said that he thought the figure a very good one. It had been drawn up at the time of the prince's birth, when Holbrook was chaplain to Henry V, then in France.[309] A comparison of A with B shows that, with the exception of the Moon, which moves through the difference of 0;17° in about half an hour, and Jupiter, to be considered shortly, the planetary positions have been taken over without change. What is most striking about this collection of material is the extraordinary degree of hair-splitting it reveals, and for this, again, Holbrook is largely responsible. He had been in the habit of quoting to as many as fourteen sexagesimal places—at least, when the mood took him.[310] At one point in the text, Thomas Southwell was castigated for his inaccurate calculations – 23;46° instead of 23;46,42°, and so on, and yet one may guess that the latter still came from the older horoscope. There is more than a suspicion here that the anonymous writer was a Cambridge man. John Langton was at this time Chancellor of the university there, and it would have been easier to canvass a critical report on the two Oxford men from someone in the other place. Of the candidates for authorship proposed by Hilary Carey, Roger Marshall, fellow of Peterhouse in 1437, Holbrook's last year as master, seems to me the most probable.[311]

The horoscope G, taken from other manuscripts than the anonymous text, is very puzzling. The cusps are very close to Holbrook's (B), being usually a minute of arc less – which represents a very small time difference (about 4 seconds of time). From the stated time ($3^h20^m56^s$) it is clear that Holbrook took the time as 3^h21^m. That this is a round

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[308] There are three inferior readings in MS Ashmole 369: Mercury is put at 222;23°, the Moon at 38;41°, and the Lot of Fortune at 171;53°. In British Library MS Egerton 889, Mercury is put at 211°.

[309] MS Ee.3.61, f. 161v. For a summary guide to Holbrook's career, see Emden (1963), p. 309.

[310] See, for instance, MS Ashmole 369, for much material of this sort. Note that there are errors of calculation in B.

[311] Carey (1984), pp. 277–81. Other names proposed are Ralph Hoby and Gilbert Kymer, both Oxford graduates.

	Lot of Fortune	Moon	Mercury	Venus	Sun	Mars	Jupiter	Saturn	Caput Draconis
A	231;19(6)	53;17(12)	254;12(6)	288;01(8)	263;47(7)	235;48(6)	135;57(4)	190;43,44(5)	145;07(4)
B	—	53;00(12)	254;12(6)	288;01(8)	263;47(7)	235;49(6)	135;56(4)	190;43(5)	145;07(4)
C	81;19(6)	263;17(12)	104;12(6)	138;01(8)	113;47(7)	85;48(6)	345;57(4)	40;44(5)	355;07(4)
D	—	49 (6)	245;05(1)	270;52,49(1)	263;46,44(1)	260;27(1)	328;10(3)	(?)40;30(6)	137(8)
E	231;39(6)	53;00(12)	254;11(6)	288;01(8)	263;46(7)	236;25(6)	—	190;45(5)	145;04(4)
F	81;39(6)	53;00(6)	254;11(1)		263;46(1)	236;25(12)		190;45(10)	145;04(9)
G	212;53(5)	39;43(12)	252;23(6)	286;12(8)	262;44(7)	235;38(6)	135;55(4)	190;37(5)	145;07(4)

number shows that G almost certainly derives from B, rather than conversely. The planetary positions in G, however, are appreciably different, and this because the very *day* of the supposed birth is different – 5 December in G, and 6 December in the other cases. That G was composed after the anonymous tract, and the associated A, should be clear from the following comparison of the ways in which the texts accompanying the figures continue:

A	G
Hec figura rectificata est per Annimodar medii celi ad instar Jovis domini et Alumptaz coniunctionis precedentis istam nativitatem, cuius locus erat 13 gr. Sagittarii. Hec autem figura et equatio domorum calculata est in gradibus et minutis secundum tabulam ascensionum signorum Mag. Johannis de Lineriis, elevatum super latitudinem 51 gr., quam estimo precisiorem pro loco nativitatis et magis accedentem ad veram latitudinem eiusdem loci . . .	Hec nativitas fuit diurna et est rectificata per Annimodar ad instar Jovis domus et Alumbtas coniunctionis precedentis ipsam nativitatem. Arcus equacionis domorum 42 gr. 20 min. Locus coniunctionis precedentis est 13 gr. Sagittarii; et nota quod in hac figura cuiuscumque domus cuspis est minutam proximam in ordinem ad minutam scriptum in angulo . . .

The omission of a reference to John of Lignères in G suggests that it is the later of the two, and the remark in G that the houses are to be taken in a minute of arc distant from the figures written in the angles of the horoscope seems to explain the slight discrepancy between the cusps in B and G. It is a strange idea, none the less, and one that I have not encountered elsewhere. It is as though the lines of the nativity were taken to have breadth – the house beginning after the line ends, so to say. Why the difference should be *two* minutes in the case of houses 1–3 and 7–9 is not clear. Apart from this small matter, there is nothing remarkable about G. By shifting the day, its author was able to move the Lot of Fortune into a different house – that which concerned children rather than life (health and disease). (Does this indicate that it was done for Henry's children?)

The Lot of Fortune (*pars fortune*) is not reported for B, but is given in the other nativities. If its longitude, that of the Moon, and that of the Sun are respectively λ_f, λ_m, and λ_s, then we can write

$$\lambda_f = \lambda_1 + \lambda_m - \lambda_s.$$

The doctrine has been explained in this way by Vettius Valens, and survived its transmission to these English writers intact, despite variant forms elsewhere.[312] It may be verified that the additions were done correctly. The significance of the Lot of Fortune is that the 'place of death' in the horoscope was supposedly to be counted from it. Another convention was to count from the eighth house.

Why, if the planetary positions in A and B are virtually the same, was it thought necessary to go to the trouble of casting a new horoscope? The planets have after all remained in their original houses, and the sky has turned by only 6;22°. The answer is to be found in the doctrine of *animodar*, which we have already met briefly in Part I.[313] Without going into the details of the justification, we can see that *Jupiter* (the planet ruling the previous new moon) has been brought to *lower mid-heaven*, to the very cusp, that is, of the fourth house. The very extensive justification for this very slight alteration in the time of the young prince's birth, with its very slender repercussions on the interpretation of the horoscope (a very long and interesting one, as it happens), can surely only be explained in terms of an extraordinary degree of belief in the mathematical minutiae of astrology, a belief that would justify cavilling over 42 seconds of arc. And of course there is one point we should not miss. Henry VI was born at Windsor, said to have been at latitude 51;00°. When we use our methods to evaluate Holbrook's accepted latitude, we get (with $\varepsilon = 23;33,30°$) a figure of 51;50,19°, showing conclusively that Holbrook had been using *Oxford* tables, rather than his own for Cambridge. As an illustration of our methods of Part I, we may determine the range of uncertainty in this example: assuming rounding up or down to the next, but not necessarily the nearest, minute, this range runs from 51;48,42° to 51;51,47°, reinforcing our conclusion.

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[312] See Bouché-Leclercq (1899), pp. 288 ff., for the early history of the notion.

[313] Section I.19.

When we do the same calculation with the cardinal angles of the Somerset/Langton horoscope, we get a figure of about 51;23,40°, showing that they were relying on a calculation done from tables for *London*. This is puzzling, for there is a good deal of discussion of the latitude of Windsor, and they seem to settle on 51;00°, after bringing in the supposed distance from London, the opinions prevailing over the direction of Windsor from Oxford, and the authority of Alfraganus ('56 miles correspond to 60 minutes of arc'). Some, we are told, thought Windsor due East of Oxford – and presumably Holbrook was among them. According to the text, there was a certain advantage in taking a round 51;00°, for this made it possible to use John of Lignères's tables of ascensions for latitude 51;00° – and yet we see that they did *not* use those tables, but tables for London (51;24°). Bolingbroke and Southwell seem to have used tables for Oxford, a deduction borne out by the text.

What is more noteworthy here than that astrologers were capable of making misleading statements is that they were clearly taking the question of latitude seriously. One might well deplore the game they were playing for its sheer futility, but the fact remains, there was a growing professionalism in the best academic astrology. When Lewis of Caerleon picked up the question of the latitude of Windsor in a marginal note, and remarked that a latitude of 51° for it (taken with 51;24° for London) was untrue, he was not worrying about geographical facts but about their consequences for the precise placing of the houses; and so for all this minute discussion in the text. There is a rather interesting passage there, with a bearing on this crucial geometrical problem. It follows on an estimate of Windsor's latitude, starting from that for Oxford, and arriving – through distances and directions – at 51;20°. But this, it is pointed out, is nearer to 51° than to Oxford's 51;50°. (Hardly the hair-splitting mentality that disputed Southwell's planetary positions!)

> Quibus suppositis, sequitur quod hec figura, equata et rectificata per tabulas ascensionis signorum in latitudine 51 Mag.J. de Lineriis, precisior erit pro iudicio eliciendo quam figura equata secundum tabulas Magistri Willelmi Rede, quas fundavit ad latitudinem civitatis Oxonie, et talis est figura Rogeri et Magistri Thome Suthwell. Supponenda est ergo ista precisa figura nativitatis istius inclitissime figure enim Rogeri quam supponit et supponere ipsum oportet pro fundamento sui iudicii, in multis necessario deficiet a precisione que tamen requiritur cum summa diligencia in nativitatibus calculandis, ut recitat Eschenden in prologo in 2m librum *Summe* sue iudicialis de accidentibus mundi. Primo deficit figura sua in minutis ascendentis, supponit enim figura sua ascendentis in Geminorum.22.25. Ista figura in Geminorum . . . [etc.][314]

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[314] MS Ee.3.61, f. 161v.

There follows a comparison of the longitudes of the individual cusps in the two figures, shown in our first table of this section. Note that there was allusion not to the tables of John Walter (the hour-by-hour tables and those of Nicholas of Lynn's calendar would have been of no use, since they were only to degrees), but rather to William Rede's. Note too that Roger is not being made to share in the credit for the Thomas Southell figure: theirs were simply very nearly the same, so were spoken of as one figure. Later in the text the writer reverts somewhat shamefacedly to the question of the small difference that separated these two. Their ascendents differed, he noted, by only two minutes:

> Quare cum figura Rogeri in tam modico distat a figura M. Thome Suthwell exemplo ductus tam scientis barbati quam magistri cum postpositus ceteris credere compellor meo iudicio pusillo nescio an erroneo iudicarem figuram Rogeri abiciendam potius quam figura M.J.H.[olbrook].[315]

'*Magister barbatus*', a bearded master, is used by Juvenal of a philosopher, and some reader has thought fit to underline the corresponding figure of speech in the text, perhaps wondering as he did so what was the point of these subtleties.

Horoscope C is a very peculiar one indeed, as will be seen by comparing it with A. Quite simply, every longitude, whether of a cusp or of a planet, is 210° greater in the later horoscope than in the earlier. The result, if meant to represent reality, would make astronomical nonsense in respect both of houses and planetary positions, but in fact it is nothing more than an *intermediate stage* in the application of the astrological doctrine of revolutions. It is worth taking warning from this example, that horoscopic fragments in this general context might well represent an astronomically impossible situation, without being in the strictest sense nonsensical. Here the end result of a long deliberation based on the writings of Haly Abenragel and Alchabitius was horoscope D – calculated, according to our text, once again according to the tables of ascensions of John of Lignères for 51° precisely. It is amusing to see that for all his earlier brave words about precision, the writer is now content to give houses to the nearest degree. He is no longer prepared to quibble with his rivals on matters of precise planetary positions, and I would guess that this was because he no longer had Holbrook to provide the necessary calculations. There is a now unnamed rival, whose horoscope for the anniversary (E) we find compared in the text with his own. Can this person be Roger Bolingbroke, still, or Thomas Southwell? Whoever it was, we can apply our usual methods to derive a latitude, and having done so we find that Oxford tables were used. Checking against the calendar of Nicholas of Lynn, and the hour-by-hour tables of the same general period, we find that the horoscope differs from them (they are in agreement here) on just one house (199° rather than 200° for λ_{11} – not a simple miscopying, since two digits are involved).

On the question of times, it is easily verified that notwithstanding the clock times appearing in the manuscript tables (see section II.), apparent ('true') solar times were in use – well calculated in A and G and (by inference) B, but less well in D – surely another sign that Holbrook's help would have been appreciated. These times are given in equal hours, even so, and not in unequal. The reference in G to the hour of Saturn is a reference to the scheme of planetary hours. By an odd coincidence, the equal hour in which the birth occurred (the fourth, reckoning from noon) would have been Saturn's, on a Friday, if planetary hours had been allocated to clock hours. In fact the usual convention was to suppose that the planets ruled the unequal (seasonal) hours, beginning at sunrise. It may be verified that the time quoted in G belongs to the eleventh unequal hour, which is also an hour of Saturn, and this fact is no doubt the reason for the allusion. (Planetary hours are assigned following the order Sun, Venus, Mercury, Moon, Saturn, Jupiter, Mars, Sun, . . . etc., beginning with the first hour of Sunday, and continuing through the week. The first hour of each day gives the day its name.)

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[315] Ibid., f. 162r.

Finally, it is worth noting that the manuscript Ee.3.61 illustrates a tendency already mentioned, whereby horoscopes attract horoscopes. Many seventeenth-century examples have been incorporated into its final leaves. Purely as an example of the inertia of taste, I mention 'Mrs Moore's figure about her husband and his being', cast for Monday, 24 January 1658, 12^h45^m p.m. It seems to have been drawn up on the basis of the tables of Regiomontanus for a latitude of 52°.

II.22. *Compound horoscopes in the work of a fifteenth-century consultant astrologer*

Evidence of a thriving astrological practice at a point on the social scale far removed from the court's is to be found in a notebook of a Richard Trewythian, who seems to have resided in London in the 1440s and 1450s. The book, now British Library MS Sloane 428, is replete with horoscopes serving many different purposes. So many of them concern horary questions that we may reasonably treat the work as a forerunner of the casebooks that survive in large numbers from the late sixteenth-century onwards. The compiler of the volume, Trewythian, does not seem to be in the English university lists, and it is doubtful whether he should be called a physician – except insofar as he was all things to all men – but no doubt the index to the Sloane manuscripts is right to describe him (for reasons I have not discovered) as an astrologer and money-lender. The astrological sections of the codex (ff. 1–138) are followed by two tracts on the general cause of pestilence, one by Geoffrey of Meaux, the other by Blasius of Barcelona. There are interpolations, such as an item in English on points put to the council by 'my lord of Yorke', presumably Richard Plantagenet, and notes on the unrest in the country in 1450,[316] not to mention later annotations by a Norwich physician; but the main body of the work is purely astrological, and indeed horoscopic.

Whether or not Richard Trewythian had a university training, he certainly appears to have had a much better knowledge of astronomy than most of those with that advantage. One cannot be certain that he calculated the ephemerides his book contains, but he clearly calculated the horoscopes, accurately, and on the Standard system. The ephemerides were very probably his. They give the planetary positions at daily intervals throughout the years from 1442 to 1458, and this to degrees and minutes of arc, using the Alfonsine tables. There were aids for this purpose developed by Oxford astronomers around 1348, that is, over and above the ordinary Alfonsine tables, and yet others developed by John Killingworth. The date I favoured for the latter when I described the Merton astronomer's tables some years ago, was 'within a year or two of 1442'.[317] It is tempting to link Trewythian's comprehensive material with Killingworth's tables, which were expressly designed for the computation of ephemerides, rather than individual planetary positions.

At the end of each line of the ephemeris, after the positions of the planets and lunar nodes in longitude, comes information on planetary aspects, again day by day. The pattern of the work is that a table running for just a year (with a 1 January beginning) is followed by horoscopes and interpretations, after which comes the ephemeris for the following year, and so on. The horoscopes have a certain intrinsic interest, by virtue of their subject matter, and the fact that this is an early document of its kind, but as far as we are concerned, the horoscopes are calculated in a perfectly straightforward way, along standard lines. They do, however, show one unusual quality: at least eighteen of them are *bordered* horoscopes, of a kind we met in section II.6 above, in connection with the astrological doctrine of revolutions. Most of the present bordered figures are double, but some of them are *triple*, and to illustrate Trewythian's style, the following material is abstracted from one ostensibly triple horoscope.[318] (For its general pattern, see Fig. 24.) It will shortly appear that it is a *quadruple* horoscope in disguise.

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[316] See ff. 119v and 53 sqq., respectively.

[317] North (1977), pp. 269–301.

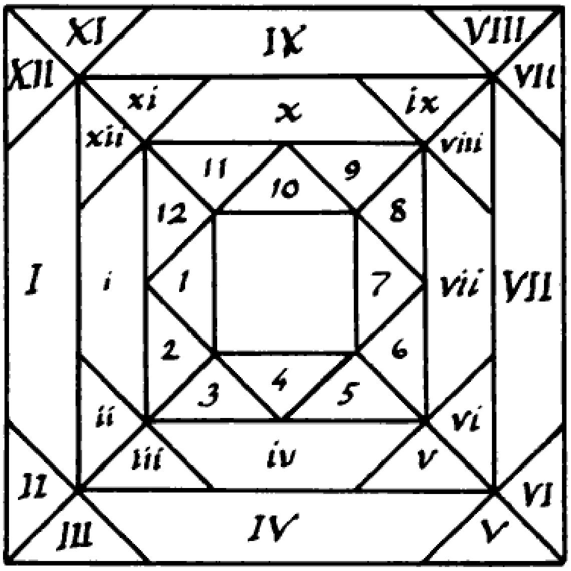

Fig. 24 The pattern of one of Richard Trewythian's compound horoscopes.

The page (f. 123v) is laid out with a heading, followed by the compound square, and below the square an astronomical statement of six lines beginning '18 grad. geminorum est gradus eclipsis solis iuxta caudam in geminis . . .'. In the centre of the compound square is a colophon explaining that the first figure (by which is meant the innermost of the three boundaries with horoscopic material) shows the situation at the beginning of an eclipse, the second figure (the inner one of the three) shows the situation at mid-eclipse, and the outer figure that at the end of the eclipse. The year is given, but nothing more. The eclipse was said to be for 1433.

There are certain odd facts about all this. The eclipse of the Sun discussed at the foot of the page was not the same as that in the compound horoscope. It belongs with the astrological calendar for 1443, and – as would later emerge – the solar eclipse was not visible in the northern hemisphere. (In these matters we follow T. Oppolzer's *Canon der Finsternisse.*)

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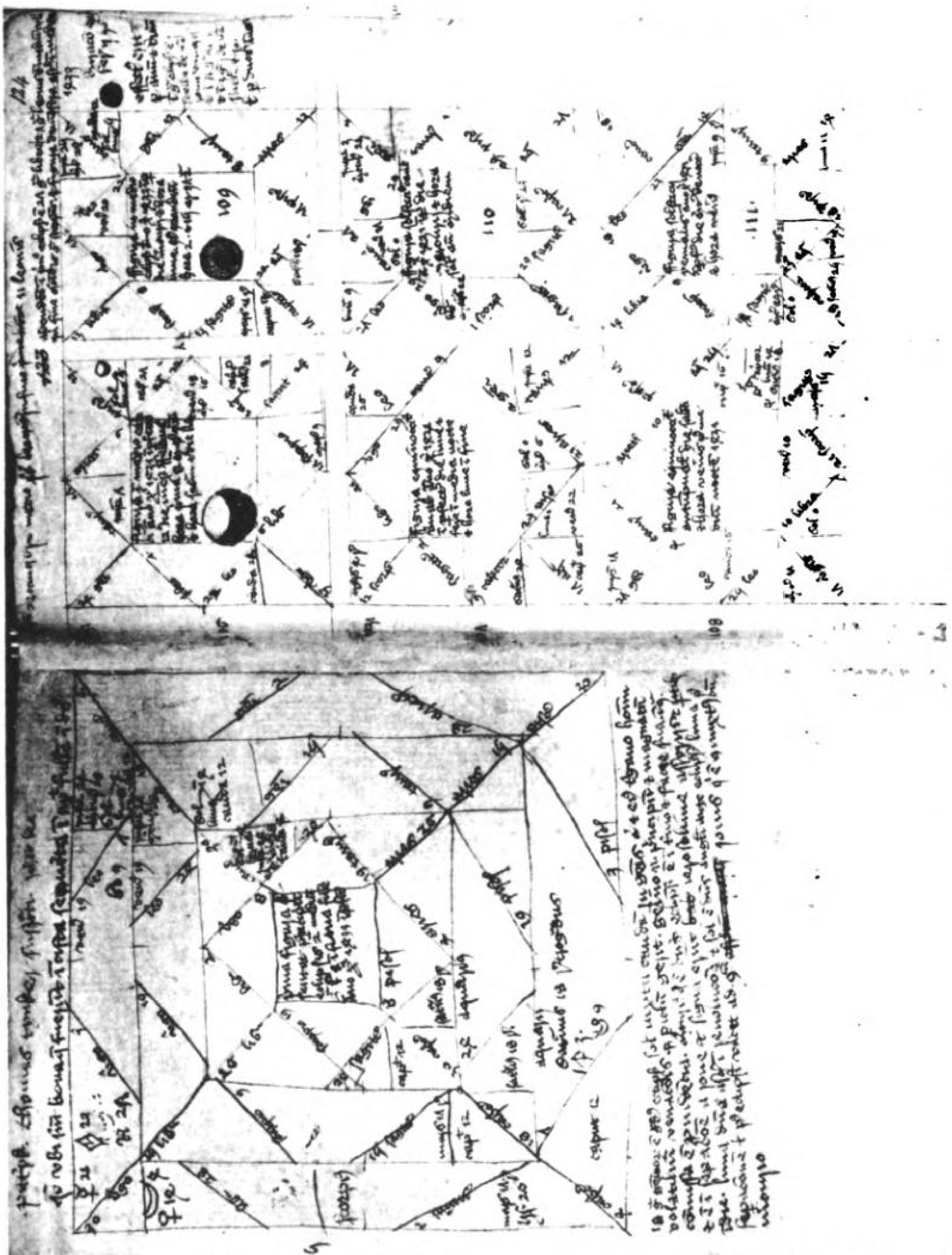
[318] Taken from f. 123v. Note that the horoscopes are drawn freehand by Trewythian, and Fig. 24 is idealized. (One oddity of this part of the codex is that it is on red-tinted paper.)



Pl. 4. Brit. Lib. MS Sloane 428, fols 123^{v} and 124^{r}

More puzzling is the heading, which at first sight seems to have nothing to do with the eclipse material. the script is contracted, and this is the best I can make of it:

> Patryk. Thomas tynker suspecti (?). Johannes Lee quo ubi sunt bona que fuerunt in cista sepulta in aperit fullam (?) in domo.

I take it that this is to be interpreted as indicating that John Lee is the querent and Patrick and Thomas the tinker are suspects in the matter of certain goods that were in a buried chest. The query as to the reading 'fullam' is because it seems probable that this refers to the place Fulham. In this case, the goods will be found in a house there. ('Aperit' is expanded from 'ap'', and probably indicates 'is uncovered', that is, by the astrologer's setting of a figure. But which figure?)

The answer is found as soon as we extract the data in the square, for in the outermost rim there are *two* sets of planetary information, one set given by the Latin names of the planets, the other set given with the help of the planetary symbolism of the time.[319] The planetary information in the three eclipse horoscopes is naturally identical (lunar movement is ignored), and is summarized in the first line of the table, while the second set of information in the outermost horoscope is given in the second line:

Saturn	Jupiter	Mars	Sun	Venus	Mercury	Moon	Caput
318R	114	257R	94	139	113	94	282
177	260	303	173	194	171	184	129

It should be immediately clear that we are dealing with astronomical configurations well separated in time. In fact we find that the first line tallies very well indeed with the state of the heavens on 18 June 1433, when there was a solar eclipse visible from Britain, while the second line fits excellently with the sky at about 9 a.m. on 7 September 1450. Note that neither has to do with 1443.

The situation then seems to be this: a consultation in 1450 led Richard Trewythian back to a triple horoscope he had drawn up long before [320] because of its aptness. The discovery of lost goods is like the uncovering of the Sun at the end of a solar eclipse. The 'uncovering phase', recorded in the outermost horoscope for the eclipse, had an ascendent and set of houses generally that were deemed appropriate to the 'discovery' horoscope for the missing goods. A solar eclipse suggests lost *gold*.

It remains to consider the three sets of houses, starting with the outermost:

λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
127	153	180	208	242	274
144	169	195	219	255	288
158	182	205	229	264	300.

It may be verified that these are well adjusted divisions, according to the Standard method for the houses. A statistical procedure for the latitude of place is not very meaningful with such a small sample, but in fact it yields a latitude of 51;25°, and at all events, the cusp-longitudes are completely compatible with a London latitude of about 51;30°.

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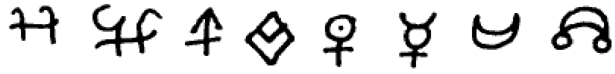
[319] Since these are not generally familiar, I put them on record here. (They are also used in the headings to the ephemeris.)



[320] It is just conceivable that he was using a blank space left in his notebook, and that he constructed the triple eclipse horoscope in 1350, the solar eclipse of 1333 being the last of which he was aware.

As a tailpiece to this section, out of the very many writings in the tradition of erecting a horoscope for an eclipse I select an important example for mention. In this case the exercise is done for every eclipse between 1554 and 1605 inclusive. The work Cyprian Leowitz's *Eclipsium omnium ab anno domini 1554 usque in annum domini 1606* . . . (etc.), dated from the French king's privilege as 1556. Leowitz (1524–1574) acknowledges the *Tabulae directionum* of Regiomontanus and the tables of Georg Peurbach. (In fact his own tables of oblique ascensions had been published with the former in 1552.) As a specimen, we may take the lunar eclipse of 1554 December 9 (he has 8), the ascendent being given as 212;31° and the longitude of mid-heaven as 131;59°. From these we derive a latitude of 48;05°, suggesting that he was working to a round number of 48°, rather than, as he maintained, 'sub altitudine poli Augustana', for Augsburg's latitude is about 48;22°.

Garcaeus, incidentally (see section II.25), gives a nativity for Leowitz in his collection, and thought highly of him. Tycho Brahe thought he should have spent less time on astrology and more on learning to calculate. One might say the same of Garcaeus himself, as we shall see in II.25.

II.23. *Houses for the people. Peter of Abano and Johannes Engel*

The introduction of printing brought with it new possibilities for the enticement of the public by astrological means. Johannes Engel was one of a new profession of astrologer to Everyman. At least eight editions of his almanachs for years between 1484 and 1490 survive, these being in Latin and German. Less ephemeral was a work he published with the press of Erhard Ratdolt in Augsburg in October 1488: *Opus astrolabii plani in tabulis a Johanne Angeli artium liberalium magistro a novo elaboratum* . . . . A new edition, using newly cut and much inferior blocks, was issued by Johann von Speier (Joh. Emericus de Spira) in 1494.

This work, much beloved of publishers of illustrated histories of astrology even today, has absolutely nothing to do with the planispheric astrolabe, at least in the ordinary sense of the phrase. It is simply a work making plain the division of the zodiac into mundane houses. It begins with tables for various climates, including tables of houses. Almost everything in the book – even the latitudes quoted for the climates – is approximated to degrees. (The climates are taken as being at approximately 16°, 24°, 31°, 36°, 41°, 45°, 49°, and 53°. Ptolemy had no eighth climate, but his 'mouth of the Rhine', at which daylight reached a maximum of 16^h45^m, was sometimes taken as such in the middle ages, and this is what corresponds to 53° in the above list.) Towards the end of the work come tables relating times of conception and birth, a calendar of saints days, explanations of the significations of the planets in the signs, of the houses for different ascendents, and finally tables of unequal hours for every climate. The section which must have been most influential, however, is the pictorial one.

This illustrated section gives horoscopic figures for each degree of the ecliptic ascendent, almost always with a central illustration. Six examples are illustrated on the following page. Inevitably, Engel had to opt for a particular geographical latitude, and it is easy to verify that all the horoscopes are for a latitude of 45°. He offered this feast of visual information, he explained, simply because the contents of the earlier section are not esaily grasped by the senses. The figures themselves were 'ab excellentissimo viro medicine facultatis doctore experto Pietro de Abano elaboratae'. This explains the choice of latitude. It is not chosen as a sort of average, half way between pole and equator, but as

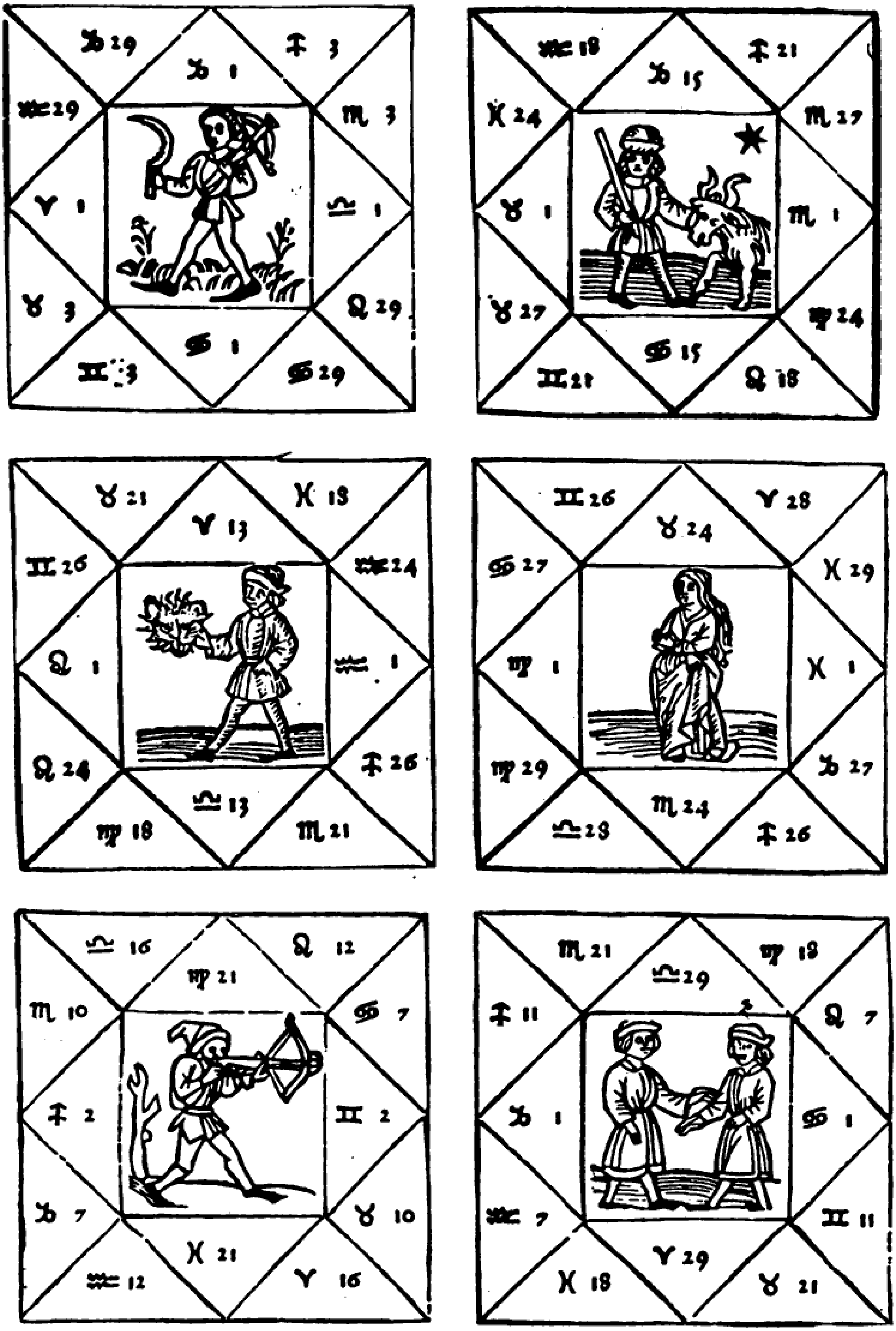


Fig. 25 Figures from the *Opus astrolabii plani* (1488).

the latitude of the Italian astronomer's domicile. (For him, of course, it had certain trigonometrical advantages.)

There is a German version of the *Astrolabium planum* in manuscript (Heidelberg MS 832), a page from which has been reproduced in several recent publications.[321] The centres of the horoscope squares (style (e) of Fig. 1 was used, as in the printed version) are there finely painted scenes, but nothing of principle is added, and the accepted latitude is still 45°.

The method used for casting the houses is the usual Standard one, even though Engel's biographers have managed to weave the name of Regiomontanus into his story. One of Engel's teachers at Ingolstadt (where he was one of the first pupils in the unviersity founded there in 1472) was a pupil of Regiomontanus, while he had talked at Würzburg with another, favourite, pupil of the great man.[322] But he did not use the 'new' method, being content to take over the calculations of the thirteenth-century Abano scholar. It seems very probable that it was the association of the work with the name of Peter of Abano that led the faculty of theology of the university of Paris to condemn it in part in a report to the Paris Parlement. We shall see something of the reason for this in a later section (II.26). Tycho Brahe also took exception to it.[323] By this time, however, the *Astrolabium planum* had achieved its purpose of bringing astrology without tears to a large audience.

II.24. *The survival of the Standard method after Regiomontanus. A Norwich miscellany of c.1500*

There was inevitably a considerable degree of inertia built into astrological practice, and it would be unrealistic to expect the 'new' methods introduced by the works of Regiomontanus to have displaced the old immediately. The old tables survived, and the old traditions died hard – a skill acquired with difficulty is not readily abandoned. In the Bodleian MS Ashmole 340 (ff. 64r–85v) we have, though, an interesting case of inertia, for there the old methods survive alongside several references to the work of Regiomontanus. There is, admittedly, no absolutely explicit allusion to his method for the houses. The date of the copy seems to be around the turn of the century, as will be seen later.

If this were all, the assortment of tables would not be worth listing. It is of interest, though, in that it shows the work of a Cambridge master in a provincial (perhaps one should say more provincial) centre, namely Norwich, working under the influence of John Holbrook, mentioned in a previous section. It includes, too, a trio of tables of oblique ascensions for an odd assortment of places, tables that we used in section I.4 to illustrate the analysis of this sort of work. The section of the manuscript in question is older than the material into which it has been bound, although the manuscript as a whole contains much astrology, from the sixteenth and seventeenth centuries, some material on magic, a calendar, and even a table of houses (ff. 10r–12v) followed by an English canon for its use (f. 13rv: 'For a declaracioun of thes tabullis be fore wryten wyche byn callyd the tabullis to domifie the 12 howses . . .'). The older section, however, is more interesting, and its contents are in outline as follows:

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[321] For exmple, Boll, Bezold, and Gundel (1974), plate XVI.

[322] As reported from Ernst Zinner by Thorndike (1923–58), vol. v, p. 345. Peter of Abano, it should be remembered, had taught at Paris (from c.1300), although the charges of heresy laid against him – of which he was acquitted during his lifetime – came after his return to Padua in 1307.

[323] For further references to the condemnations, see Thorndike, loc. cit.

(64r) 'Ut intres duplici introitu in tabulis equacionis domorum . . .'. A canon for the standard method, with a worked example based on a table of type T_1'. Interpolation done wrongly. Only MS listed in Thorndike & Kibre (col. 1620).
(64v) A canon for solar motion with a note saying that 4′ are to be added to the motus of the Sun at *Cambridge*.
(65r-) Table of type T_1 for right ascension, possibly closer to al-Battānī's than the usual Toledan. (The differences are of the order of a minute here and there, and miscopying makes it hard to discriminate).
(66v-) 'Tabula 2e domus et 12e [sic] ad latitudinem 48 gr. et 16 min.'. This oddly titled table is in reality for oblique ascension, of type T_2, for a latitude 48;16°. It is the table (B) that was analysed at the end of section I.4, where it appeared to be based on $\varepsilon = 23;30°$ or thereabouts (possibly as high as 23;33° or more).
(68r-) 'Tabula 3e domus et 11e ad longitudinem [sic] 32 gr. et 55 min.'
(69v-) 'Tabula 1e domus et 7e ad latitudinem 52 gr. et 19 min.'
These last two are tables (C) and (D) in our analysis at the end of I.4, and again they are found to be, not simple tables of houses, as the titles seem to suggest, but tables of oblique ascensions of type T_2 for the stated latitudes, and based on obliquities close to 23;30°. We can dimly see what was in the mind of the writer, in giving them their titles. Note this remark at the foot of the last table: 'Ex ascensione recta medii celi per additionem continuam 30 graduum nasci solent ascensiones oblique reliquarum quinque domorum'. Now it is true that by adding three times 30° to the right ascension of mid-heaven we get the oblique ascension found in a table of type T_2 opposite the correct value of λ_1, but it is not true that by using the same table similarly (i.e. inversely) with, for example, $\alpha_{10} + 30°$, we shall be able simply to take out λ_{11} (after interpolation). What was in the writer's mind? It seems fairly clear that he had read something about Regiomontanus's method, as explained in section I.10 above, but that he had not understood all its ramifications.

I take it that (D) is a table for Cambridge, while (B) might be connected with John of Lignères (see section II.13 above). Table (C) is not for any convenient clima (by applying the method for M given at the end of section I.4, we find approx. 14^h11^m). The latitude is near those of Tripoli, Damascus, and Baghdad, but not near enough for them to be probable. (Like Tripoli in Libya, Damascus was usually – and here – given as 33;00°.)
(70r-) A table for reducing time to degrees and conversely; equations of time for the years of the cycle 1401–4; table for lunar motion with a reference to Regiomontanus, and others with longitudinal separations between Nuremberg and Cambridge (1^h05^m), Norwich (1^h01^m) and Oxford (0^h52^m). These do not speak well for a sense of topology. There follows a solar table drawn up in Cambridge in 1430 (solar aux at the end of the first degree of Cancer), and a table of geographical positions (thirty-three places, including those already mentioned, York, Damascus, Cologne, etc.). Paris is 48;32°, there is no 48;16° or 32;55°, but as noted above, Damascus was given as 33;00°. (See further Appendix 2, below.)
(77v-) List of stars and table of radices of planetary motion. Note the two dates of 1460 and 1492 here. The first is in a statement that material is drawn from John Holbrook ('Mag. Holbruk') of Cambridge (78r); the second is in a note added to a statement that 6844 is the year of the world: 'when the yere of Cryste was 1492 then were the yeres of the worlde 6691, and this is after [i.e. according to] *Cronica Cronicarum*'. The drift of this is that the English gloss is following the chronicle of Eusebius, so called 'school reckoning', and taking creation as at 5199 B.C., while the original statement must have been based on a date more than a century earlier. But what date? There are very many traditions that would make 6844 a late fifteenth- or early sixteenth-century date. A date of 5351 B.C. from Augustine would give us exactly the 1492 of the gloss; the Septuagint's 5330 B.C. would give 1513; and so on. We should probably favour the 1492 date, and take it that the passage was written soon after.
(78v-) A table of houses from the same period, with a short canon (82v: 'Cognito gradu solis in

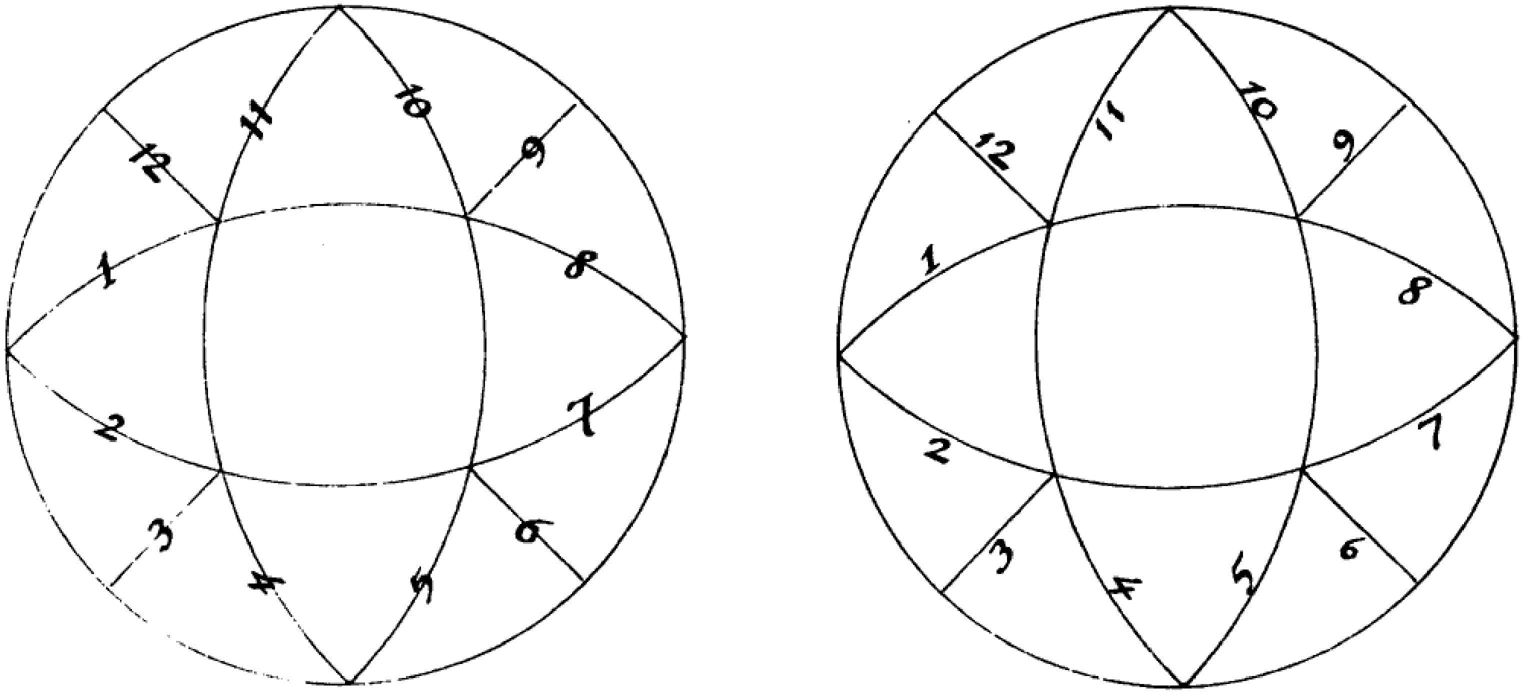

Fig. 26 In the sixteenth century the confusing – but more logical – custom spread rapidly of writing the longitudes of the cusps of the houses on the lines of division, rather than on the spaces of the figure. (This custom does not only extend to circular figures.) Unfortunately, since the printer could not set type to fall across a rule, and since he did not cut a block for horoscopes, in most cases, he tended to move the type to the nearest available space – avoiding, for instance, a house crowded with planets. The results can be very perplexing, without a key to the rationale of the new figure. The rule is simply: associate each dividing line with the longitude alongside it, whether to one side or the other. The right hand figure gives an example of what a printer might make of the key figure on the left.

quocunque signo per instrumentum vel per almanake . . .'). this ends: Et iste modus est satis preciosus pro iudiciis questionum, secundum Mag. J. Styke de Norwico'. There follows a table and canon on the exaltations ending similarly: (82v) 'Explicit tabula domificandi [sic] Mag. Johannis de Norwico'. After some solar tables and empty leaves, the entire section ends at 85v.

This last table of houses, by John Styke of Norwich, but not copied by him (he could hardly have made such a mess of the task), gives the houses only to the nearest degree. It is not taken from Nicholas of Lynn, nor is it in the tradition starting from the ascendent. As in the tables of John Walter (to take just one set as an example) the degree of mid-heaven is down the left of the table. John Walter's table was of course to minutes. For all its remark about the precious method of the table, and for all the allusions to Regiomontanus elsewhere, this table is done according to the *Standard method*. It is only moderately well calculated, for the latitude of Norwich (which is given as 52;40° in the table on f. 76r). The moral is clear. For all its 'rationality', the new method was not easily mastered for computation from first principles. As computational routines slowly became familiar through other printed works, the method came into its own. It was to become a method for use by rote, rather than by hard thinking.

II.25. *Regiomontanus and the flood of sixteenth-century horoscopes*

As we saw in Part I, Regiomontanus was not the first to use the system he made so popular, nor, strictly speaking, was he the astrologer who precipitated the fifteenth-century renewal of interest in alternatives to the standard method of casting the houses – this dubious honour belongs to Gazul. Regiomontanus's written and printed works were nevertheless the most important single cause of the revolution in technique that came about in the late fifteenth- and early sixteenth-centuries. In a rather indirect way his work seems to have had a baneful effect on the level of astronomical awareness shown by astrologers practising their art. There was, indeed, a surge of popular interest in astrology in the sixteenth century, but astrologers ceased, it seems, to have a good intuitive understanding of what domification entailed in a geometrical sense. For most, as I have suggested already, it was a procedure to be done by rote. The fact that Regiomontanus's tables were those most easily acquired for a wide range of latitudes meant that his system became that most favoured. No-one seems to have troubled to ask whether one method of domification was invariably truer than another – but that is a historical problem outside the scope of this study.

In themselves, the new tables were no easier to use than the old. They had a certain cachet – they were new, and (so it was said) more rational than the old. But it is more to the point that they were for a whole range of latitudes, catering for pan-European needs. They encouraged a high level of activity in the non-academic world, and the fact that this is largely ignored in the present work is only because they offer no new point of principle which is not more easily illustrated from printed sources dealing mostly with the famous. It might be worth studying both academic and private astrological practice to see whether astrologers less captivated by publicity tended to stay longer with the old methods, but it is doubtful whether the tendency can have been very pronounced, if it existed at all. Books including horoscopes of famous men and women became increasingly common. There is a fine precedent in Firmicus's nativities of Oedipus, Paris, Demosthenes, Plato, Pindar, Archimedes, and others, considered as moral types. Girolamo Cardano's *Exempla geniturarum* also served as a work that was in some ways a prototype, but in others a warning. It was a prototype in that it included figures for men of letters, princes, politicians, churchmen, artists, and so forth. It was, on the other hand, astrologically naive, both as regards interpretation and technical detail, and it opened up astrology to new criticism.

There were several manuscript collections of a comparable sort, many of them far more competently done,[324] but they could not satisfy a firm public demand; and what did the public as a whole care for technicalities? It was the biographical element, whether confirmatory or predictive, that mattered. Cardan's 1543 (first) edition included sixty-seven genitures, and this number was later expanded to a hundred, the hundredth being Albrecht Dürer.[325] Cardan, who was born in Pavia in 1501, was by 1543 lecturing on medicine in Milan. In 1552 he was invited to St Andrews to treat John Hamilton, archbishop of St Andrews and primate of Scotland, for asthma.[326] Shortly before departing from Lyons, on his boat journey northwards, he was shown a Latin edition of Ptolemy's *Tetrabiblos,* which he proceeded to study and comment upon, adding to his commentary twelve horoscopes, including one of Christ. This was all ready for the French printer by the time he reached Paris! The horoscope of Christ will be discussed in section II.26 below. (It was omitted from the 1578 edition of the commentary, but is available in the *Opera* published in Lyons in 1663.) On returning from Scotland he visited the English court, and cast another notorious horoscope for the king, Edward VI – notorious because so inaccurate in its predictions.

Cardan's work is notable, from our point of view, simply because he used the crude *Single Longitude method* (numbered (6) in our I.14) for casting the houses. One cannot say that this had any more or less intrinsic merit than the alternatives – but it was certainly a method for a man in a hurry. All houses are at the same degree of their zodiacal signs, and the only calculation needed is that for the ascendent. Cardan did not usually bother to calculate the ascendent to better than the nearest degree. He often quoted the latitude of the birth (in the central square – he followed style (e) of our Fig. 1), and yet this was of no consequence for his procedure. He was simply picking it up from his sources, in some of which it had been needed for the Standard calculation, with which he had dispensed. He usually gave date and time, the latter being needed, of course, for the ascendent, and the former potentially useful for the same purpose. As for Cardan's high-handed way with other astronomers' work, we have seen elsewhere[327] how he transformed the nativity of 'Hali 'Rodoan' into one on the Equal Longitude system. (It has to be admitted that the change is not apparent on my notation for classifying horoscopes. By virtue of the value of the ascendent longitude, mid-heaven is altered only in the minutes, and both are written (000270m).) He did likewise for Haly's friend's nativity, which fore-ordained that he should 'voluntarily throw himself in the water'. (Here it changes from (201112m) to (201111m). Note that the minutes of the ascendents have been corrupted in the course of transmission, but that is another problem.)

There are some ironies in Cardan's work. Bearing in mind Luther's overt antipathy to astrology, it is amusing to find his horoscope (item 11); and in view of all that Regiomontanus had done to revise the practice of domification, it might have been thought an insult to his memory that his nativity was cast in such a primitive way. It is doubtful whether others who had been brought before the public gaze cared quite so much about this point as about the interpretation and prognostication offered. Among these others were Henry VIII of England, Osiander, Erasmus, Dürer, and a number of Italian towns (Venice, Milan, Bologna, and Florence).

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[324] Several are mentioned in Poulle (1969).

[325] For most purposes, the best edition may be taken as that of Joh. Petreius, Nuremberg, 1547. Its compound title is *De supplemento Almanach; De restitutione temporum et motuum coelestium; De iudiciis geniturarum; De revolutionibus; De exemplis centum geniturarum additis insuper tabulis ascensionum rectarum et obliquarum* . . . [etc.].

[326] Morley (1854) is full, and about as reliable as anything dealing with his very unreliable subject is every likely to be.

[327] Section II.5.

This kind of publication became increasingly popular, and one of the richest collections in the genre may be taken as an example of practice half a century later. This was the collection by Johannes Garcaeus, a native of Saxony: *Astrologiae methodus in qua secundum doctrinam Ptolemaei exactissima facillimaque Genituras qualescunque iudicandi ratio traditur* [etc.], Henr. Petrina, Basel, 1576. This expensively printed work testifies to demand at the upper end of the market, where astronomical competence should surely have been expected. In fact the slipshod ways which a too rapid consultation of easy tables encouraged are evident even in the horoscopes where the writer was most anxious to flatter.

The horoscopes in question are interesting for other reasons. They are for the Holy Roman Emperor Maximilian II, born in Vienna (with longitude and latitude given as 48;22° and 35;08°, respectively), and Augustus, Duke of Saxony and Elector (longitude of Freiberg given as 30;39°, latitude as 50;58°). Two examples for each ruler come on the reverse of the title page and the page following, one of each done by *Regiomontanus's* tables, and the others '*ex sententia Firmici*', namely the same Single Longitude method as had been used by Cardan. It is possible that there was a feeling that this latter had its classical origins to recommend it. As for the Regiomontanus-type figures, invariably, as things turned out, the tables were used incompetently. They were – in the figures mentioned – always used for the wrong latitudes, and the mistake was repeated again and again throughout the book. On p.220 there is another figure for the Emperor with a marginally different ascendent, and yet another implicit latitude (47° instead of 48°). On p.12 there are two more for the Elector, one with an implicit latitude of 66° rather than 39°40′, again using the Regiomontanus system, but one '*ex sententia Campani*'. This last, one of the few moderately well calculated examples in this lavishly printed folio volume, was not done by the author at all, but by the 'most studious and skillful' mathematician and astrologer Bernhardus Flavianus. The praise is excessive, but the case is an interesting proof of the fact that one astrologer of note did not feel himself competent to dabble in the so-called method of Campanus (the Prime Vertical method).

Garcaeus, like most compilers of horoscopes, tended to present them to the public not so much for their own sake as to illustrate general principles. This naturally gave them an added value, for practising astrologers could use them as patterns for their own prognostications. One sad little example is the nativity of a sister, Elizabeth, who died before her first birthday, used to illustrate the indications that a child will die early.[328] Another – rather more careful than most – is his own.[329] Osiander, Erasmus, Luther, and Copernicus are among the hundreds of subjects in this collection, each with a large square, usually covering half a folio page. On the face of things, the work is much more carefully done than Cardan's. The planets are often given to minutes of arc, as are the house divisions. The times are usually to minutes, and latitudes are almost always inserted. (To the nearest degree, since that is all Regiomontanus usually allowed!) But on closer examination, errors abound. Much of the material is obviously borrowed from elsewhere, and has not been reworked. Many of the dates of birth are idiosyncratic (note that this is too early for calendar reform problems), and the latitudes too. To give but three examples: Copernicus, born at lat.53°, is put at 55°; Erasmus, born at 51;55°, is put at 54°; Edward VI of England, born at 51;22° is assigned to 52;30°. Even the horoscopes themselves do not follow the stated norms. There is very little to be said for the book as a whole, considered as a guide to astrological theory, but as an indicator of astrological practice one fact stands out clearly: *the Standard method of house division has disappeared from view*. We are reminded of John Dee's remark, quoted in section I.9. He intended to follow, he said, the method of Regiomontanus, 'for that all menne nowe doe soe'. This was written twenty years before Garcaeus, and things were not destined to change quickly.

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[328] See pp. 39–41. She was born in Brandenburg (lat. given as 52;36°) in 1519.

[329] Dated 1530 Dec. 13^d 13^h 28^m p.m., lat. 52°. Done by the tables of Regiomontanus.

As to the question of changing fashions, the tendency in the seventeenth century is for elaborate horoscopes to have their underlying rationale openly acknowledged. For a time, astrologers became more aware of the alternatives, and if they were not writing for themselves alone, they usually made this fact explicit – for example, by writing the name of the tables used, over the figure. Private casebooks – as those by Simon Forman, William Lilly, John Booker, and Richard Napier, to take examples now in the Bodleian Library – usually reveal the influence of Regiomontanus and his successors. We recall that his *Tabulae directionum* were easy enough to use, albeit a shade inaccurate. They were not as easy as a table of houses proper, for your own latitude; and here Johannes Stadius came into his own, in the late sixteenth-century, providing another bonus in the form of an ephemeris, which obviated a good deal of tedious planetary calculation. Another material factor in the mass production of horoscopes was the now ubiquitous clock, although rectification was still called for when a nativity was needed long after the birth, and there was often a need to rack the memory for such detail as that 'the birth occurred whilst the mother was at dinner'. Approximation was the order of the day. When we apply our usual methods to deduce the accepted latitude of place, this usually turns out to be taken to an integer degree, or perhaps to the half degree. (Note that Lilly favoured 52° for his London work, and had tables on the Regiomontanus system to minutes, but none too accurately done.) As for the speed with which a practised astrologer could work, Ashmole's biographer, C. H. Josten, has estimated that he took between seven and fifteen minutes on interrogations.[330] This he could do simply because there were so many tabular aids.

In analysing the rise and fall of astrology, therefore, it is a mistake to do what is so often done, and treat the question only in terms of demand. Supply, too, plays an important part – and this is dependent on the ease with which astrologers, many of them without formal intellectual training, could answer enquiries. The evidence of surviving casebooks is that by the seventeenth century this might be done at the rate of a thousand a year, or more. An awareness of the fact that there were alternative methods of equating the houses does not seem to have slowed astrologers down. (The awareness might have cheered them, since – as at the upper end of the market today – it showed the way to a ready excuse when things went wrong.)

The streamlining of technique made for democratization. Horary questions were dashed off for lost treasure, drunkenness, breach of promise, disease – the list was endless. Astrologers could afford to give attention to the lower end of the social scale; and it seems, from the evidence of the best of them, at least, that they did not cut many corners, or fudge their calculations to gull a trusting public. This obviously has something to do with the temperament of the astrologer. It is hardly surprising, for instance, that there is nearly as much care in Richard Napier's hastily written scheme for 'Christopher, Old Woodfield', sixty years old and with a pain in his abdomen, as in his schemes for the local gentry[331] – hardly surprising since we are dealing with the kindly and prayerful rector of Great Lindford, who as Aubrey tells us was constantly in communion with the angel Gabriel.[332] Other guardian angels gave lessons in economics, and yet at the back of all astrology there tended to be a scientific motivation of sorts. This is not an unreasonable way of characterizing the urge to assemble those monumental collections of classic nativities that found a ready market in the sixteenth century, but even the casebooks of astrologers are often found to intersperse the nativities of famous individuals taken as character-types. Francis Bernard's casebook, now MS Sloane 1707 in the British Library, is a good example.[333] Such activity was taken seriously by men whose scientific purpose we can easily enough accept. In a final section I shall mention some activities within the orbit of the infant Royal Society. Here we might add a reference to the care with which Elias Ashmole compared the nativity of Sir John Davis with information on his monument in

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[330] Josten (1966), p. 469.

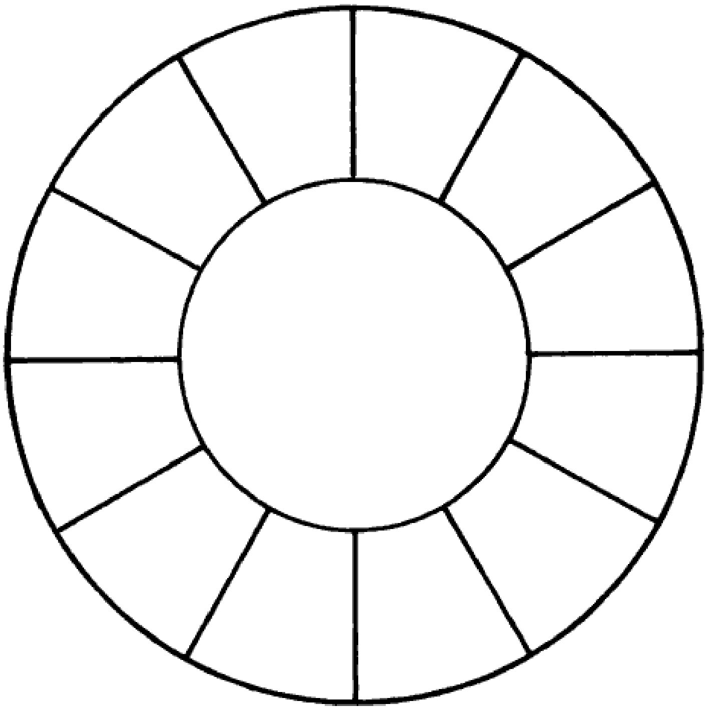

Fig. 27 A style found in the mid-seventeenth century casebook of Francis Bernard, now British Library MS Sloane 1707. The casebook includes a few other figures, in style (d) and in that of Fig. 26.

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[331] The example is taken virtually at random from a very extensive collection in the Ashmole collection, MS 1414, p. 441. The horoscope is (225153m), on the Regiomontanus system, i.e. the Equatorial (fixed bounds) method, for latitude 52° (deduced). The date was 1597 August 18, and 'hic dies admodum serenus'.

[332] Note that he was instructed in astrological technique by Forman, whose manuscripts he inherited.

[333] Note the very characteristic circular style of the figures in this work of Bernard's (redrawn in Fig. 27). As a specimen horoscope from the casebook, I select John Cockshute's, for which the cusps, commencing with the longitude of mid-heaven, are 77/117/147/170/192/219. This is for 3 March 1640, and is of Equatorial (fixed bounds) type for a London latitude. There is an interesting passage on the use of logarithms for the circles of position ('horizons', circles through N′ and S′ on Fig. 2).

Pangbourne church.[334] By an odd coincidence it seems he was knighted at the sack of Cadiz by Essex in 1596 at the same time as Christopher Heydon, whose work we shall examine shortly.

Scientific motives, however, had little to do with the acceptance of any particular style for the equation of the houses. Here England remained in the grip of the Regiomontane tradition throughout even the seventeenth century. Such *jeux d'esprit* as we shall find Heydon and others countenancing were only for the most refined of tastes.

II.26. *Nativities of Christ*

It must have seemed to the ordinary medieval scholar that the writer of the Gospel according to Matthew, by including the story of the wise men and the star at Christ's birth, was giving *carte blanche* to those who wished to treat the event astrologically. Some have since thought that he was indeed looking to the persuasive powers of a then fashionable art, in support of his other teaching. As early as the fourth century, Chrysostom was finding it necessary to deny that the passage sanctioned astrology. The medieval debate over free will and celestial determinism took on an especially serious shade of meaning when Christ's birth was considered. Some were wise enough to avoid the subject entirely; others spoke of the stars as a sign, or as a foreshadowing, of Christ's birth; some separated the human character of Christ from the divine, and said that the former was subject to the same astrological determinants as were the characters of other men; while others avoided such debate entirely, and simply applied to Christ's nativity the rules they had learned from the standard astrological writers. This last practice continued in Protestant countries long after its explicit condemnation by Urban VIII's inquisitor Cesare Carena (Papal Bull of 1 April 1631).

Three names in particular are mentioned again and again in this connection: Pietro d'Abano, Cecco d'Ascoli, and Pierre d'Ailly. The bones of Peter of Abano (1257–c.1315) were, it is true, disinterred and burned some decades after his death, but this seems to have been more for religious heresies and a reputation for necromancy than for anything plainly astrological.[335] There are references enough to necromantic images in his writings to betray more than a passing interest in them, although the precise form of the ideological controversy to which his bones were hostage is now unknown. He was quite conventional in adhering to the doctrine that great conjunctions are concerned with patterns in world history, especially with the rise and fall of religions; and inevitably Christ came into the account, although this was nothing new. If he drew up anything approaching a nativity of Christ in his *Conciliator,* it is likely to have been a horoscope of an event heralding the rise of Christianity (a conjunction of Jupiter and Saturn). We shall return shortly to this type of 'horoscope of Christ', which is likely to have been more innocuous than a personal nativity of Christ. Horoscopes occur elsewhere in *Conciliator,* as relevant to the effectiveness of persons making incantations.[337] This sort of writing was spiritual dynamite.

Cecco of Ascoli (1269–1327) was more notorious still, and died at the stake for his actions, but again it is more likely to have been his necromantic teachings that first led him into difficulties. The determinist thesis he seems to have proposed must also have offended sorely. Worse, he insisted that Christ's life and death were implicit in the figure of his nativity.[338] It may be surmised that he cast a full horoscope for Christ, but if so, we do not have it. Cecco no doubt angered many by his criticism of cities on the basis of the old doctrine that they and their inhabitants were influenced according to climate (the latitude factor), province (Ptolemy had correlated provinces with the heavens), and the moment of building (the ascendent factor, so to speak).[339] This last doctrine was, as it happens, especially pervasive in Italy, and foundation horoscopes form a distinct genre with a long history. As for the doctrine of great conjunctions, like Pietro he held to it firmly, but now embroidered it with the principle that succubi and incubi reside in the colures of the equinoxes and solstices, and that Christ and other religious figures were born under their influence at times of great conjunctions.[340]

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[334] The question concerned the granting of his knighthood and baronetcy, said on the monument to have been at Cadiz. Father (b. 1560 Feb. 8) and son (b. 1611 April 3) were of the same name. Their nativities were (165070m) and (142039m). Both were done by the Equatorial (fixed bounds) method, the father's more carefully than the son's. See MS Ashmole 423, ff. 81–2. Note also the information there culled from the 'Milan Almanack for the yeare 1682', all of it possibly acquired with an astrological potential in mind.

[335] For bibliography, see the DSB art. by Loris Premuda, vol. i, pp. 4–5.

[336] I have found none in the copy in MS Canon. misc. 190.

[337] Thorndike (1923–58), vol. ii, p. 900.

Peter of Ailly (1350–1420) was by comparison a staid figure – ending his life, in fact, as Cardinal, although this did not give him dispensation from Cesare Carena's censure, in which he was mentioned by name. D'Ailly shared the 'historical' interests of the others, and the broad principles of the doctrine of great conjunctions, but he objected to those who placed Christianity under the governance of the stars. Roger Bacon seems to be his target here, with his belief that the Christian religion was subject to Mercury.[341] The Cardinal nevertheless repeatedly argued for the influence of the stars on the lives of Christ and his mother, the Virgin, this influence reinforcing their natural virtues. He objected on points of detail to Abū Maʿshar and the author of *Speculum astronomie* (taken to be Albertus Magnus) for putting the birth of Christ at a moment when the ascendent was in Virgo (see below). It was, he thought, in Libra. Similarly he thought the conjunction heralding the coming of Christianity to have been in Cancer rather than Taurus, as previously stated. These criticisms come in chapters 2 and 14 of his *Elucidarius,* published at Louvain by Johann Paderborn in c.1483, but available in several manuscript copies. This work was to prove influential, as we shall see when we come to examine the personal horoscope of Christ that it contains.

The oblique manner whereby Christian authors tended to approach this sensitive subject, through world history rather than through a figure for the moment of Christ's birth, was provided, of course, by non-Christian authors for whom the whole matter was a much less sensitive one. In the following table are given the 'impersonal' horoscopes to be found in the works of a number of standard writers on the subject.

The fundamental Māshā'allāh horoscopes need careful explanation. The first is for the vernal equinox at the outset of the year in which a Saturn-Jupiter (great) conjunction occurred. From this, the astrologer calculated that Christ would have been born at the end of the thirteenth year, so the second horoscope is for the vernal equinox at the beginning of the year in which Christ was supposed to have been born. The horoscopes are thus to be dated 23 March –25, and 22 March –12 (Julian calendar). Both were seen to

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[338] Thorndike (1923–58), vol. ii, ch. 71, weighs the evidence very judiciously.

[339] Ibid., pp. 955–6. City horoscopes are to be found in the writings of Gaurico, Cardan, and Junctinus. It seems that modern astrologers set great store by them, sometimes with more than a nod from the city fathers. See, for example, Boll et al. (1931), pp. 106–7, 113.

[340] The text comes in Thorndike (1949), p. 408.

[341] Thorndike (1923–58), vol. iv, pp. 104 ff. Peter of Ailly actually himself wrote on the interpretation of ten horoscopes relating to great conjunctions, the last of which was for 1425, inc.: 'Pro declaratione decem dictarum figurarum . . .' in Bibl. Jagiellońska, Cracow, MSS 575, ff. 108r–111r, 584, ff. 56r–59ra, 586, ff. 66v–70rb – all of them 15th cent.

		Occasion	Actual Jul. date of equinox		λ₁	λ₁₀	Method for houses	Geog. Lat. deduced
A	Māshā'allāh (fl. 762–815)	vern. equinox preceding conj.	23.03.–25	b′	91°	Ar.–	(6)	—
B		vern. equinox preceding birth Chr.	22.03.–12	b′	198	Can.–	(6)	—
C	Abū Ma'shar	ditto			ditto			
D	Mūsā ibn Nawbakht (860–940)	vern. equinox preceding gt. conjn. (fiery triplicity ending)	21.03.96	d	278;27 267	197	(2)′	14;38° (centre Earth, see sect. I. 18) clim. IV (stated)
E	Abraham bar Ḥiyya (fl. pre 1136)	vern. equinox preceding gt. conjn. (earthly triplicity beginning)	22.03.34	lit.	276	205 (195 Lat.)	none	approx. 34° (see sect. II.7)

Notes: The dates given here are the correct dates of equinox within the quoted (equivalent) year, whether or not the event happened in that year.

The style of the drawn figure is indicated with reference to Fig. 1. By b′ is meant a figure where the ascendent is put at the top.

Method for houses: by (2)′ we denote a horoscope in which the degrees within the signs are not quoted, except for the cardinal points.

indicate, but for reasons that are not very clear from the text, the violent death of Christ by crucifiction.

David Pingree, in his commentary on Māshā'allāh's astrological history, has shown its hybrid character.[342] The underlying chronology depends on a *millennial* theory (counting in thousands from an early date, in fact –8291 in this work) rather than a conjunction theory, and in this it differs from the chronology of Abū Ma^{c}shar, who reckons from the date of the Deluge, supposed marked by the conjunction of all planets at about the vernal equinox of –3101. On this basic Zoroastrian scheme Māshā'allāh has grafted the Sasanian theory of writing history on the basis of conjunctions. The grafting required certain chronological shifts, one of which in fact occurs at the birth of Christ, while another indicates the birth of the prophet Muḥammad.

	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon	Dragon
A	Leo	25;24	110	0;01	—	Ari.	153	—
B	286;28	152;30^{R}	81;22	0;01	44	4;59	82;44	—
C	286;28	152;31^{R}	81;22	0;00	44	(25;15)	82;04	25;15
D	147;40	128;12	278;27	0;01	339;03^{R}	331;00	98;27	326;14
E	144	124	324		21	341		

Pingree notes that the horoscope here designated (B) is copied in the work of as-Sijzī, in the *Ta'rīkh al-Ya^{c}qūbī*, and in the *Dastūr al-Munajjimīn*, with a number of variants in the planetary positions quoted.[343] The *Dastūr* has a different ascendent (7;18° or 4;38°, presumably Libra). He further notes a Latin work of c.1351 with a series of five horoscopes evidently newly calculated, but in the tradition the astronomer has learned from Abū Ma^{c}shar.[344] None of these concerns Christ, but it is clear that there was much activity on this score in the Latin West, prompted in part by Pierre d'Ailly. There is in Paris BN Lat.7336, for instance, a horoscope of Christ that Nicholas of Hungary said he took from Albertus Magnus – we shall meet it shortly –, this being associated with a number of conjunction horoscopes. The collection was perhaps assembled a decade or two before a letter of 6 April 1465 from Jacob von Speier to Regiomontanus, asking, among other things, about the application of astrological methods to predicting the course of Christian history, and asking too about ways of determining the year of Christ's birth astrologically, from the horoscope of the preceding great conjunction.[345] This bespeaks an extraordinary degree of faith in astrological methods, but of course the procedure is precisely that which Māshā'allāh had applied.

In a rare printed work evidently delivered to Pope Leo X (who held office from 1513 to 1521), Tiberio Rossigliano Sisto of Calabria took issue with certain monks (?) on the question of whether Christ's human body was subject to celestial influence, and if so, in what way: *Tyberii Russiliani Sexti Calabri Apologeticus adversus Cucullatos in Quatrigentas Quaestiones disputatas* (etc.).[346] (The word *cucullatus*, hooded man, might be taken to refer to any one of the scholastic writers considered in this section.) There he collected together earlier horoscopes, the essential details of which are summarized in the tables on the following pages. The first of these is of horoscopes of the world at its creation; the others concern the horoscopes of Christ's nativity.

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[342] Kennedy and Pingree (1971), pp. 69 ff.

[343] Ibid., p. 97. For al-Sijzī, see also Pingree (1968), pp. 70ff., esp. p. 81. He dates the work of al-Sijzī at some time after 925 A.D., and sees it as a sort of supplement to Abū Ma^{c}shar's *Kitāb al-ulūf*.

[344] Kennedy and Pingree (1971), pp. 187–90.

[345] Curtze (1902).

[346] I am grateful to Prof. Paola Zambelli for providing copies of the relevant pages of this work, from an original in the Magazine Library.

Rossigliano's book is highly informative, but also derivative, and to be treated with caution. His numerical data, surprisingly enough, are still recorded in Roman numerals, with all the risks they entail in the hands of the printer. (Some of the mistakes are here corrected silently from internal evidence, but others no doubt remain uncorrected.) Like so many others, he was much concerned with scriptural chronology, and on the well-worn subject of the *thema mundi* (or *thema caeli*) he ran through a number of classical discussions – Plato, Rabanus, Grosseteste, Comestor, Ashenden, d'Ailly, to name only a few – before finally reproducing four horoscopes in diagram form. He did sketch a number of others in the text, drawing usually on Ashenden's *Summa*, it seems, but they give virtually no information as to how the houses were equated, and I ignore them here. The four figures reproduced in detail are designated a to d in the next table. These, he said, were according to:

a. the Jews and Chaldeans; b. the Arabs and Egyptians;
c. the Latins; d. Aesculapius and Anubis.[347]

The last item in the table (e) comes from Pico, reporting Peter of d'Ailly, but is also to be found within the text of Rossigliano, where it is associated only with an ascendent and mid-heaven. It is there anonymous.

It will be seen that a, b, and d are done according to the Equal Longitude method, the houses being at the first (a and b) or fifteenth (d) degree of each sign. The Standard method was used for c, and analysing it we are led to suppose that it was probably calculated for the first clima (latitude a little under 17°). The last item (e) is problematical, and will be considered shortly.

The fourth on this list is in fact the best known of all *themata mundi*. It was reported by Ashenden from Julius Firmicus Maternus and Macrobius, but there is no reason why Rossigliano should not have taken it from them directly – most probably from Firmicus' *Matheseos*. There (III.1) we are told that Petosiris and Nechepso followed the teaching of Aesculapius and Anubis, to whom Mercury (Hermes) had entrusted his secret. The Sun, Moon, and planets were in fact put at the fifteenth degree, each in its zodiacal domicile – the Sun in Leo, the Moon in Cancer, Saturn in Capricorn, and so forth. The ascendent coincides with the Moon's position, and mid-heaven with 15° Aries. We saw in section I.3 that Firmicus held to a primitive view of the house divisions. On the geniture of the world he was more subtle, as he needed to be, believing that the world had no origin. The *thema mundi* was provided by ancient divines as an example for astrologers to follow in the nativities of men!

The third on Rossigliano's list, 'coeli thema in eius origine secundum Latinos', is certainly wrongly described, for it is based on oriental ideas. The Indian horoscope of a great man (mahāpurusa) put all the planets at their exaltations, precise degrees of the zodiac at which the planet was supposed to have special virtue. The earliest example of this kind of horoscope is datable to 269/70.[348] When the Sasanians took over the idea, they made use of it for the horoscope of Gayomart, the first man, whose birth was taken to coincide with the beginning of all planetary motion. The Sasanians used the Greek figures for the exaltations, rather than the Indian, and it is the Greek that we find in Rossigliano. I have elsewhere argued that this type of planetary configuration was in Dante's thoughts when he wrote the first canto of the *Inferno*, and this later Italian source is for that reason

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[347] Fols C.ii.v and C.iii.r.

[348] Pingree (1975), esp. p. 6. The exception to the exaltation rule is Mercury, which cannot be there, so far from the Sun. Here Mercury is put at 33°.

	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon	Drag. (asc. node)
a.	1	Tau.	Gem.	91	Leo	Vig.	241	241	211	1	57	75	91	
b.	91	Leo	Vir.	181	211	Sag.	321	348	237	181	181	—	1	
c.	10	44	75	105	[132]	160	207	105	299	19	327	33	33	
d.	15	45	75	105	135	165	285	255	225	135	195	165	105	
e.	1	40	67	91	123	173	321	358	238 200	19 41 19	57	75	33	63

Note: The figure of 132 (horoscope c) is altered for the sake of consistency from 122. The data on the line opposite e are from Pico's text (report of Pierre d'Ailly), those below the line are variants taken from his drawn figure (edn. of 1601, Basel), the figure above the line being the only variant planetary position in Rossigliani's text (fol. C ii^{r}, not associated with d'Ailly).

very welcome, since I was previously dependent on a rather ambiguous mural painting for Italian support.[349]

Rossigliano refers briefly to Pico della Mirandola's book 'impugnationum', by which he means the *Disputationes contra astrologos,* and it is from this work that I have taken the thema e, to be found in Rossigliano's book only in a descriptive form, with no cusps for the houses given, apart from the cardinal points. As I said earlier, it is anonymous in Rossigliano. Pico's book had been in print since 1495 or 1496 (printed Bologna), included in the second part of his *Opera* and edited by his nephew Giovanni Francesco Pico della Mirandola. Pico took horoscope e, he tells us, from Peter of Ailly's 'concord of history and astrology'. Some of the numerical details come in the text, others (and alternative readings) in drawn figure. It is instructive to compare the data with those above them (a to d) in our table, for they present a most extraordinary pattern. It is as though the horoscope was assembled by drawing at random on older *themata mundi*. Reading across my table, this is how the pattern of borrowing seems to go (a dash denotes that there is no obvious borrowing):

a . . . a (cusps, specific longitudes added to a) b b? b? c a a c -.

It goes without saying that this mixing of elements, if indeed that is what was done, makes nonsense of the exercise. Equally nonsensical are the actual cusp longitudes quoted, at least on any of the systems we have found advocated in the history of our subject. The longitudes of ascendent and mid-heaven are only possible at the equator – unless we are dealing with the Single or Dual Longitude methods, or the Equatorial (moving boundaries) alternative, which simple inspection shows cannot have been the case. And at the equator, the three fixed boundaries methods are all equivalent, and the house cusps are for all of them the longitudes equivalent to right ascensions of 30°, 60°, 90°, 120°, etc. These do not fit the cusps of horoscope e, which in this further respect thus seems to be either very corrupt or incompetent. The former seems more probable than the latter alternative, in view of Peter of Ailly's horoscope for Christ, to be discussed later in this section.

We come now to the horoscopes for Christ in Rossigliano's book. The first (F in the table below) is, by implication, from his own calculation. Next is one from Peter of Ailly (G), while the last (H) he assigns to Albumasar and Albertus Magnus – by which he undoubtedly meant that it was to be found in the *Speculum astronomie* customarily taken to be by Albert. The last horoscope in my table (J) is from Cardan, and is included here for later convenience. It has no obvious link with Rossigliano's work, although a connection cannot be ruled out.

Rossigliano tried hard to make his account comprehensive. His having piled up names of authorities does not by any means imply that he has examined them all. It is obvious, for instance, that he depended heavily on Pico, and Pico's readings of earlier astrologers, even though the two men took very different views of the subject. Pico had argued in his fifth book against the theory of great conjunctions as a key to history, at the same time censuring Abraham 'prince of the Jews' (bar Ḥiyya, whom he distinguishes thus from ibn Ezra) for the sort of 'prediction' that we find based on E, that a prophet was to be expected.[350] Perhaps reflecting on his misspent youth, when he was a believer in the art he is now castigating, Pico goes on to show that if interpreted according to the best

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[349] North (1982), esp. pp. 15–19.

[350] Section V.12.

		λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3	Sat.	Jup.	Mars	Sun	Ven.	Merc.	Moon	Drag.(asc. node)
F	Rossigliano	97;40 (95;40?)	123;42	153;49	185;44	218;11	247;48	$74;05^{R}$	[188;17]	10	[272;52]	319	277;05	32;44	267;??
G	d'Ailly	96	128	156	188	221	251	74^{R}	[187]	9	272	318	276	(?)30;28	228
H	'*Speculum*'	64	97	135	158	188	218	75^{R}	189	10	271	319	296	34	—
J	Cardano	92;53	123	153	182;43	213	243	$74;17^{R}$	188;03	9;56	272;53	318;36	276;38	28;05	268;??

astrological principles – and note that he is fond of Maternus – the horoscopes of Christ do not yield the most conspicuous facts of Christ's known life, of which the most significant was his cruel death and the manner of it.[351] Pico perhaps saw himself as one who was like Albertus Magnus, in having begun life in error only to see the light at a later stage, and reject astrology. This is a misreading of Albert's views on astrology. I accept here Thorndike's interpretation[352] of Pico's attack on certain superstitious books on astrology by 'Roger Bacon and the man of York, and not by Albertus Magnus' as an allusion to the *Speculum*. The *Speculum* was nevertheless plainly in Rossigliano's mind when he claimed to be quoting Albert, and it was from this book that he took several of its many allusions to Albumasar, and to the thesis that the birth of Jesus to a virgin was signified in such and such a way in the heavens.[353] We shall soon discover that he or some earlier reader took some liberties with the text, having first seriously misunderstood it.

The last on my list, J, by Cardan, belongs to an earlier period of his life than the commentary we had occasion to discuss in section II.25. It was the subject of sceptical comment by his early biographer Gabriel Naudé,[354] who was following the examples set by Auguste de Thou and J. J. Scaliger, and who was followed in turn by a host of other writers who effectively forgot that there had been earlier horoscopes cast for Christ.[355] In John Milton's *Paradise Regained* (IV.382 ff.), Satan offers to foretell Christ's destiny by celestial signs, and actually mentions conjunctions, and it seems that eighteenth-century critics had no doubt but that the allusion was to *Cardan's* presumption in casting Christ's horoscope.[356] There is some justification for this brushing aside of earlier history, for Cardan's *interpretation* of the nativity was the most thorough available. It seems to have been first drafted around 1532, the interpretation having been added between 1536 and 1539.[357] It cannot have done his case any good when he was charged with impiety in 1570, and imprisoned for a time.

So much for the circumstances of the nativities of Christ. No doubt there are others, but the nineteen introduced here will serve to show certain clear tendencies. From the planetary positions, a hiatus is evident between E and F, and this is – as I explained at the outset – between (1) impersonal, conjunction-type horoscopes, or rather the horoscopes for the onset of the year in which they or other events occur, and (2) horoscopes keyed to the supposed birthday of Christ, 25 December of the year 0. The planetary positions under (2) are all reasonably well calculated according to the *Toledan* tables. (We must assume that in the three cases where square brackets have been added in the table, the classic mistake was made, perhaps by copyists, of putting the planet in the wrong house, as a result of being misled by the name of the zodiacal sign.) The slight variations between the longitudes stated are not worth pursuing: they might arise from attempts at an adjustment for geographical longitude, or simply from rounding procedures, or a time difference within the day. The position of the Moon at midnight on 24 December was in fact about 30;20°, and all data for the Moon's position are commendably close. How far it is possible to speak of independent calculation here is hard to say. One thing, at least, is clear: d'Ailly's and the supposed Albumasar/Albertus scheme are very close in planetary longitudes, and in that same respect there is really nothing at all new in Cardan's work, as may be seen at the very least by looking at Rossigliano's.

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[351] Section V.14.

[352] Thorndike (1923–58), vol. iv, p. 531.

[353] See p. 173 below.

[354] 'Vita Cardani [etc.]' in Cardan (1663).

[355] For the Naudé passage and other useful material, see Shumaker (1982), ch. ii.

[356] Milton (Carey and Fowler edd., 1968), p. 1155.

[357] Ibid., p. 59.

The significant differences between the figures cast, in short, relate to the house divisions. This is where the astrologer showed his individuality. As Rossigliano remarks, five different ascendents are favoured by astrologers: 3°, 5°, 8°, and 10° of Libra, and 8° of Virgo. He gives no example with 3° Libra, and probably takes this from Pico.[358] The others are exemplified, respectively, in F, G, and H. Cardan, strange to say, seems to have opted for the unused alternative! Or is there some other horoscope still to be found, from which Cardan took everything?

That the cusps of the houses differ is not, of course, wholly due to the different ascendents accepted. The methods adopted in the earlier horoscopes (A to E) are shown in our first table: the Standard method was used except by Mūsa ibn Nawbakht, who used the Dual Longitude technique. The four birth horoscopes seem to have been done in the following ways:

F. (Rossigliano): Standard method (1), badly calculated, possibly for the third clima, or even the second. (These horoscopes are all classic cases of uncertainty in derived latitude, since λ_1 is near to 180°.) Rossigliano gives the latitude as that of 'Jerusalem or Bethlehem', which he puts at 32°.

G. (D'Ailly): Standard method (1), probably subject to copying errors. Perhaps done for the first clima.

H. (*Speculum*, supposedly): the cusps are badly calculated on any system. The Hour Lines (fixed boundaries) method gives the best results, but even then the root mean square of the differences is 3.6°. Latitude possibly around 41°. See below.

J. (Cardan): Single Longitude method (6), the cardinal angles being left unrounded. The precise choice of ascendent was obviously due to scriptural belief about the moment of Christ's birth. (Such considerations were what led Pico to state the ascendent at 10° Libra.) Since Cardan makes the Sun's longitude equal to the cusp longitude for the fourth house, it is clear that he meant the time of birth to be local true midnight. He seems not to have realized his mistake. By opting for the trivially simple method (6) for the houses, he has sacrificed the principle of an elementary equivalence of λ_4 and *imum medium coelum*. In his text, incidentally, he gave the latitude of Jerusalem as 32°, the standard figure; but again this is irrelevant to his method for the houses.

This last point about solar longitudes and lower mid-heaven did not escape Pico. As he scathingly remarked, the astrologers we are discussing did not know their art well enough to get such details right. Note that only Cardan's Sun is on the 'midnight line'. That Pico's hand had not lost its cunning, even though his faith in astrology had disappeared, may be judged from the fact that he matched up longitudes of 6°Cancer and 10°Libra for ascendent and mid-heaven, respectively. The geographical latitude implicit in these is close enough to the standard 32° for Jerusalem.

We return, finally, to the text of the *Speculum astronomie*, ascribed by some, but by no means all, to Albertus Magnus. If I have not paid much attention to it, this is because it is a rather trivial compilation, interesting only inasmuch as it tells us what was being read at the time it was written. The second reason is that the horoscope that Rossigliano associated with it is quite certainly alien to it. To see why this is so, we need only turn to the text in Borgnet's edition. There is no actual horoscope there, but there is a discussion of the interpretation of Christ's horoscope in abstract and general terms. There is this passage on the ascendent, which is certainly supposed to lie within the sign of the Virgin, but not at any particular degree. This is the text:[359]

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[358] In V.14, Pico speaks of certain astrologers who take this as the ascendent, but he gives no further details.

> Et jam scimus quod sub ascendente ejusdem partis coeli, scilicet Virginis, natus fuit Dom. Jesus Christus, cum hoc quod aequatio motus octavae sphaerae in tempore nativitatis eiusdem fuit *octo* gradus et triginta septem minuta et duorum secundorum secundum calculationem certissimam: et quod ipsa erat tunc minuenda de locis planetarum inventis per canones . . . (etc.)

Some reader of this text has very probably picked up the word I have italicized, which concerns the movement of the eighth sphere at the time of Christ's birth (a precessional parameter, which we need not consider further in this place), and has taken it to be the degree ascendent within Virgo. He then, presumably, built round the ascendent longitude his own idea of what the natal horoscope should be – for a latitude of about 41° – and did so very inexpertly. For this reason, there is no point in our treating the horoscope seriously – there is certainly no evidence that it belongs to the thirteenth century.

This spiritually exhilarating if dangerous pursuit of casting Christ's horoscope did not disappear with the sixteenth century. There were Restoration clergymen prepared to try their hands at it, and even today there are some, it seems, who are able to get a frisson or two from its practice. They should have lived in Cecco's time.

II.27. *Renascence and reform: systems of eight houses*

A passing reference was made in Part I to a system of eight houses, explained by the first-century Latin poet Marcus Manilius in his poem *Astronomicon*. Although the purpose of the poem was to instruct in the art of astrology, and although it is the oldest comprehensive work on that subject known to us, it appears to have had little influence, and certainly the system of eight houses had very few discernible repercussions before the renaissance interest in his text. The *editio princeps* was by none other than Regiomontanus (Nürnberg, 1473/4), and a revival of interest in it followed the edition by Joseph Scaliger, which edition first appeared in 1579. Bouché-Leclercq took Scaliger to task for discarding the concept of eight places (ὀκτώτοπος), and for wanting to add the eight places to four centres, making the familiar twelve cases.[360] I am not concerned here with the correct understanding of Manilius's text and intentions, or indeed with his sources – for that particular trail might at a stretch of the imagination lead back to Egypt or the cultures responsible for northern European megalithic monuments. What does seem at least plausible is that the discussion that centred on Manilius's text prompted certain astrologers to produce their own versions of the eight point scheme.

The first example is not a very convincing one, but ought to be mentioned, since it might possibly derive from a reading of the first Manilius printing. It is a horoscope drawn in the form of a four-pointed star within a circular surround, radial lines between the points of the star serving to divide the circle into eight (see Fig. 28). The scheme appears in a printed work of 1499 and concerns the crowning of its laureated author Conrad Celtis on 18 April 1487, by the Holy Roman emperor Friedrich III.[361] The significant property of

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[359] Albertus Magnus (Borgnet ed., 1891), vol. x, p. 644.

[360] Bouché-Leclercq (1899), p. 276.

[361] I have seen only the reproduction in Koch and Knappich (1959–60), vol. ii, p. 76 – itself reproduced from another secondary source. The original text is entitled *Proseuticum*.

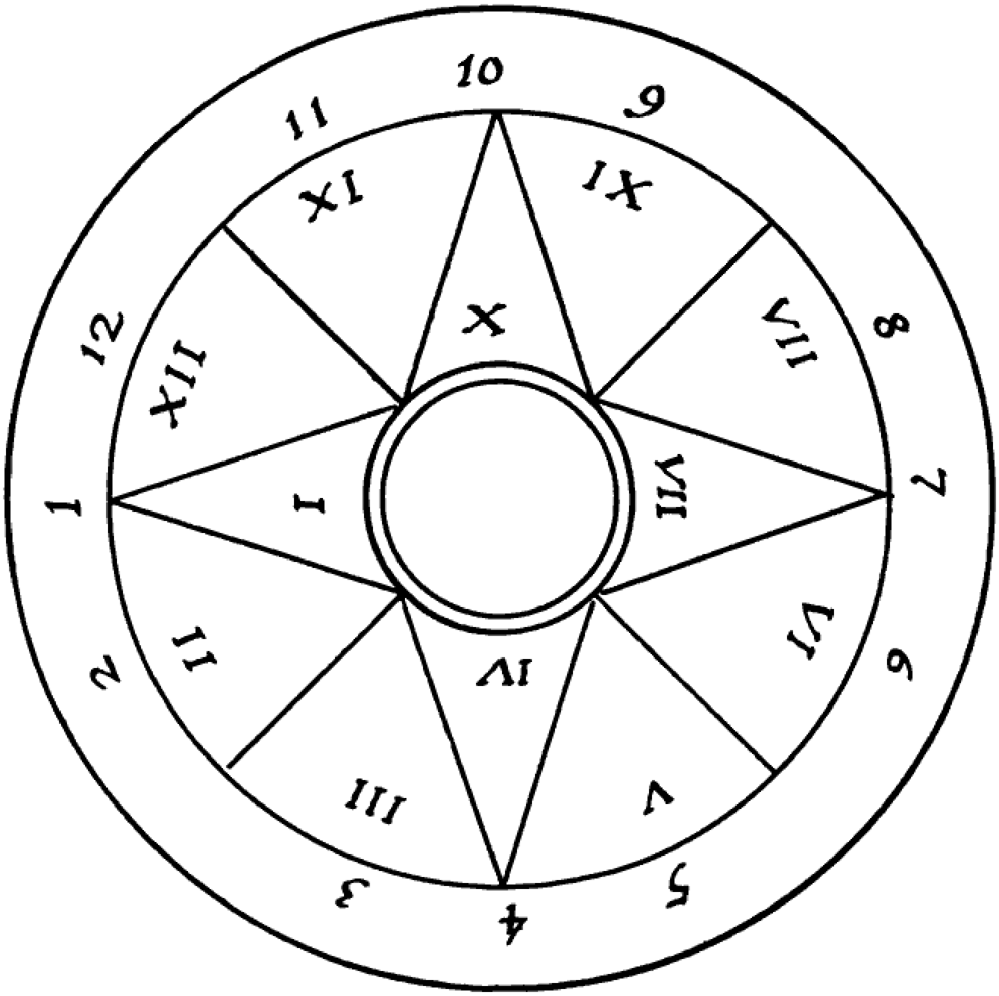

Fig. 28 The style of figure adopted for the horoscope of the crowning of the poet laureate Conrad Celtis in Nürnberg, 1487. Cusp longitudes are placed where I have written arabic numerals, planetary longitudes where roman numerals. The text says that the figure was set up for the day of the crowning by Johannes Kanter of Groningen.

this configuration is that it is used to carry information about *twelve* houses, divided in the *Standard* way (and not, as Walter Koch would have us believe, after the style of Campanus). The way the figure is completed would fit very well, in fact, with Scaliger's way of presenting Manilius. The printed text says of the figure that it was erected for the day in question 'per Johannes Kanter de Groningen Frisie astronimum (*sic*)'. Annual prognostications by Kanter (or Canter) are extant for the years 1488, 1489, and 1491, and in them he styled himself 'imperial astrologer'.[362] The horoscope is not a true eight-house construction, and we may leave it with a list of its cusp longitudes, and the observation that they are moderately well evaluated for a longitude in the neighbourhood of 49;27° (Nürnberg). The second line in the table gives ideal longitudes for that latitude, and an obliquity of 23;33,30°, accepting the figure for mid-heaven:

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[362] These and many similar works by other astrologers (including M. Polich, who drew up a prognostication for the Emperor for 1489) are mentioned by Thorndike (1923–58), vol. iv, p. 455.

	λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
Given longitudes	122	149	177	205	240	271
Calculated:	122	148;17	176;22	204;42	238;55	270;26

While Kanter's has all the appearances of an eight-house horoscope, it is not so. A diagram looking very much as though inspired by it or a common source – the Regiomontanus Manilius, perhaps – is to be found in a rare early printing of Tycho Brahe's first significant astronomical work. The scheme is reproduced in the adjacent figure. The book concerned the new star of 1572.

The circumstances under which the work was published have been explained at length by J. L. E. Dreyer in his biography of Tycho.[363] Shortly after his work appeared, the Royal Danish Academy of Sciences issued a facsimile of the original book, *De Nova et nullius aevi memoria prius visa stella* (etc.), first printed at Copenhagen in 1573 by Laurentius Benedicti.[364] Tycho first saw the nova on 11 November 1572. He believed, like most of

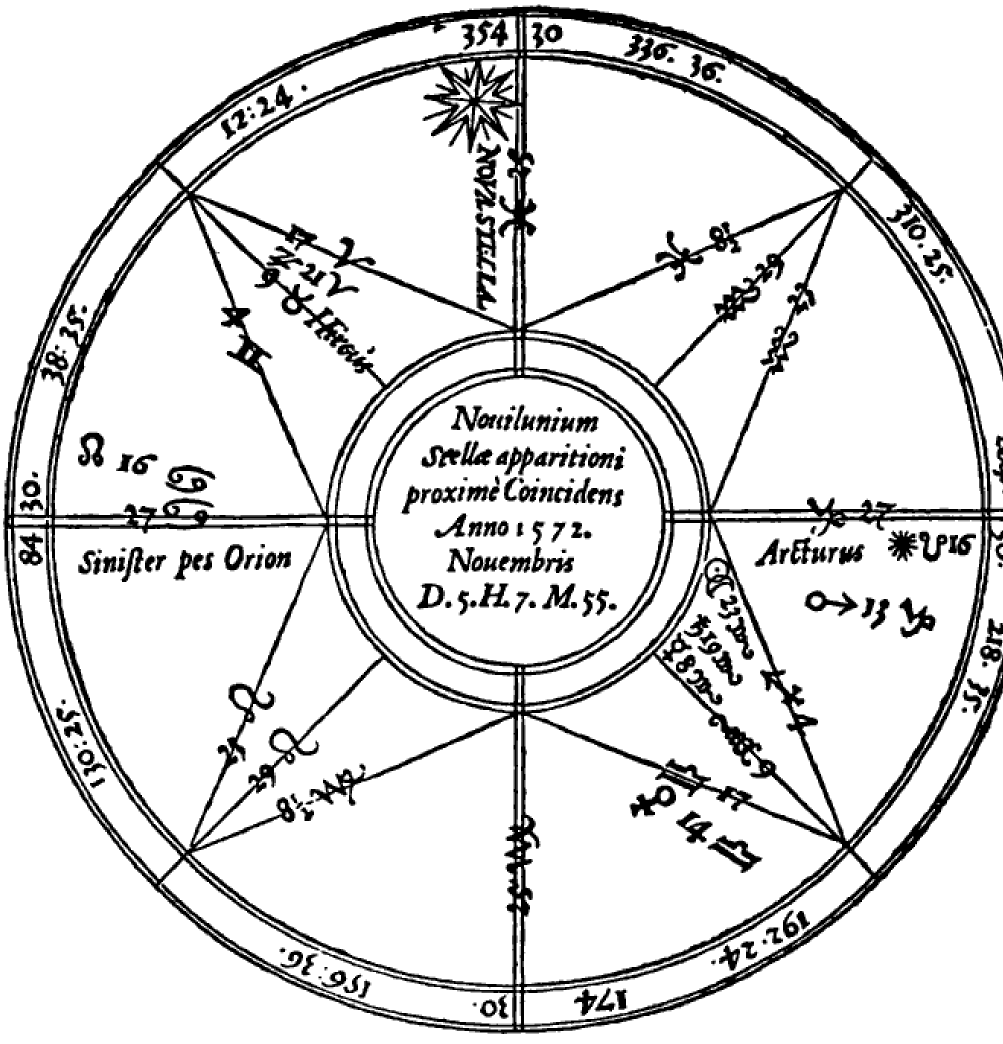

Fig. 29 Tycho's four-point twelve-house horoscope for the nova of 1572.

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[363] Dreyer (1890), pp. 42 ff.

[364] Copenhagen, 1901. This reprint seems to have been largely distributed by gift.

those who later saw it, that it had an astrological significance, but of course there were no real precedents. At this stage of his life, Tycho inclined to give the apparition a meteorological interpretation; later he would turn to its supposed effects on the human mind. It was when deciding on the date of its first appearance that he had recourse to a horoscope: he simply adapted a method advocated for comets by ʿAlī ibn Ridwan, and decided that its first appearance was during the conjunction of Sun and Moon on 5 November 1572 – which he knew almost to the hour (7^h55^mp.m. was his estimate, as may be seen from the centre of the scheme). Introducing an astrological interpretation of its significance, he explained the principles on which an almanac should be constructed – the sort of astrological diary Kanter and dozens of other astronomers published – and criticized his fellow almanac-makers, announcing his plan to expose them in a book *Contra astrologos pro astrologia*. This seems never to have been written; but more to the point, one of two treatises he says he has already written seems not to have survived, and in one of these he explained his method for a horoscope.[365] Perhaps he used its essentials in the book in hand, for there we find all we need to comprehend his new scheme.

Tycho shows us that he favoured an eight-house scheme over one with twelve houses because of the influence of the Moon, and the fact that its cycle is divided up into quarters. But how to settle on the dividing points of the zodiac for the eight houses? He did not want a simple 'zodiac division, like many Arabs; or a division from the poles of the equator, like Albategni; or based on the division of the equator from the intersections of the horizon and meridian, as in our age was done by Regiomontanus'.[366] He was prepared to mention authors until he came to his own favoured way, and then he gave none; but it was, as we might have guessed by elimination, the *Prime Vertical* (fixed bounds) method commonly given to Campanus, except that the prime vertical was to be divided into eight rather than twelve, and the 30° steps in the algorithms for equating the houses will now become steps of 45°.

Turning then to the horoscope for the conjunction of 5 November, we find these as the longitudes of the cusps:

λ_{10}	λ_{l}	λ_{1}	λ_{b}	λ_{4}
355	39	117	149	175
355	37;24	117;27	152;06	175.

The first row records his data, taken from what is written on the truly radial lines in Fig. 28, while the second row records my calculation, based on the figure for mid-heaven, and an obliquity of 23;30°, with a latitude of place of 56° exactly. This last figure is provided for us by Tycho, who tells us that it is an approximation to the latitude of Copenhagen (Hafnia) that he himself measured, namely 55;40°. His calculations are not of the highest quality, and we can see a mistake on the figure itself. This is a suitable point to mention a convention often observed, especially in the sixteenth and seventeenth centuries, of putting the value of α_{10} in the top centre of the square (as it usually is – but here a circle), and the value of α_0 at centre-left. These are, in Tycho's case, in error by a degree, and his calculation rested on them, of course.

It seems, therefore, that Tycho has revived an ancient style, having shaped it to his own taste, in the Campanus–Gazul tradition. He seems to have been following a hint by Cardan, and was in turn followed by another influential Danish astronomer, Thomas

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[365] *De variis astrologorum in caelestium domorum divisione opinionibus, earumque insufficientia.*

[366] The book is not paginated. See f. F2v.

Fink (or Fincke; 1561–1656) of Flensburg, author of a treatise now rarely cited, *Horoscopiographia, sive de inveniendo stellarum situ astrologia* (Schleswig, Nicolas Wegner, 1591). He does not seem to have been inspired in any way by Manilius directly.

Fink was a good, if not original, geometer, and his *Geometriae rotundi, Libri XIIII* (Basel, 1583), was admired and used in its day, including as it did compendious trigonometrical tables (drawn largely from those by Georg Joachim Rheticus) with which to implement the spherical trigonometry of the main text. Fink's new work was dedicated to Heinrich Rantzov (Ranzovius or von Rantzau in most German works), the learned governor of the duchy of Holstein, and the book was filled with different versions of a horoscope, set for Rantzov's nativity. Fink's starting point was very probably Rantzov's own computations, which I have found in several of his own writings (to Regiomontanus's method, with $\lambda_1 = 226;03°$, $\lambda_{10} = 156;57°$, for Steinborch in Holstein, 11 March 1526, etc.). Fink's work again included tables that his readers must have appreciated greatly, including tables of houses for nine European latitudes,[367] but our own interest in it stems from the sheer comprehensiveness of his collection of illustrative nativities, or rather schemes for one man's nativity. The key chapter is xvii, where he draws schemes in a conventional way (style (e) of Fig. 1), in a similar way for eight houses (see Fig. 30), and in a composite way combining the two.

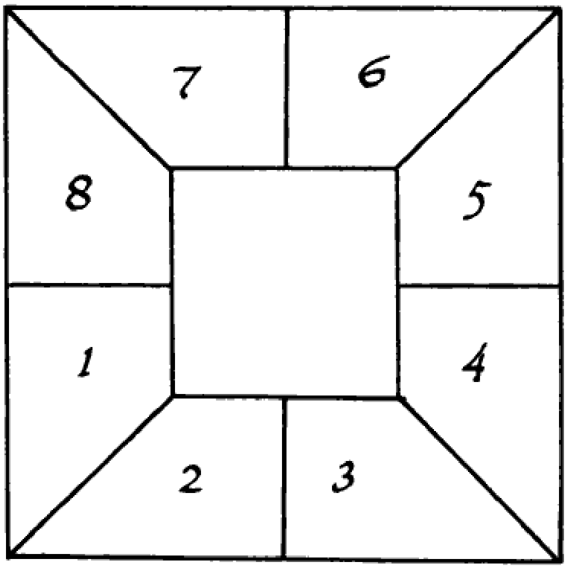

Fig. 30 Thomas Fink's pattern for eight-house figures.

I ignore the twelve-house figures, which add nothing to what we know of the traditions of the day. To introduce his division of the ecliptic into eight houses we shall need an addition to our standard notation. Exactly the same symbols will be used as before for the cardinal longitudes (λ_1, λ_4, λ_7, and λ_{10}), but the longitudes of the cusps between them will now be denoted by λ_b, λ_e, λ_h, and λ_l, circulating in an anti-clockwise sense from the ascendent on the figure. The reason for reserving other literal subscripts will be evident later. Fink gives five different schemes, for which the cusp longitudes λ_b and λ_l are as follows:

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[367] Based on Regiomontanus's *Tabulae directionum*, for latitudes at 2 degree intervals from 46° to 60°, and an extra table for 55°. There are also comprehensive tables of ascensions.

	A	B	C	D	E
λ_b	279;41	267;19	289;53	280;53	270;29
λ_l	191;27	187;30	185;54	190;53	180;29

They are all to be taken in conjunction with values of 225;29° for λ_1 and 156;18° for λ_{10}. The time of birth of Rantzov was given as 1526 March $2^d 10^h 31^m$ p.m., and the geographical place as of latitude 55° and longitude 32°. The latitude fits excellently with the cardinal longitudes quoted, on the assumption that the obliquity is 23;30°.

The five different versions of the eight-house horoscope are all easily verified. They are accurately calculated (all within a minute of arc, for an obliquity of 23;30°) using methods analogous to five traditional methods:

A – Standard method, now bisecting the right ascensional (cardinal) arcs.
B – Equatorial (fixed bounds) method, the 'horizons' dividing the equator now into arcs of 45°.
C – Prime Vertical (fixed bounds) method, the prime vertical now being divided by the 'horizons' into arcs of 45°.
D – Dual Longitude method, the four non-cardinal cusps of the houses bisecting the cardinal arcs in longitude.
E – Single Longitude method, all houses being 45° in extent, starting from the ascendent (and thus overriding mid-heaven).

The only significant omission is the Hour-lines (fixed bounds) method.

In analyzing the figure by Tycho Brahe (Fig. 28) I made no reference to certain rather puzzling lines, namely those forming the points of the star. (I mentioned only what I called 'truly radial' lines.) Now that we have seen Thomas Fink's very general treatment of a single nativity, and in particular his habit of compounding horoscopes with eight and twelve houses, perhaps we can interpret the extra lines as evidence of a compounding of horoscopes. It seems to me clear that there are indeed *three* eight-house horoscopes on this one diagram, and that the non-cardinal longitudes are to be grouped as follows:

	F	G	H
λ_b	143	149	158½
λ_l	64	39	17

The cardinal points are of course shared. Here horoscope G is that which we have already found to be calculated by the Prime Vertical method. It seems highly probable that F was prepared by the Equatorial method of Regiomontanus, for which correct values are 143;10° (λ_b) and 66;37° (λ_l). I cannot see the source of the data for H. They are not from the Standard, the Dual Longitude, or the Single Longitude methods. At all events, we can see the rationale of the drawn figure: if a planet falls within the points of the star, there is a possibility of conflicting interpretations, as offered by adherents of the different schemes.

It is hard to say how widespread these new interpretations of a classical text became, but at least one influential writer in England was greatly attracted by the idea of going back to the purity of the eight-house arrangement. MS Ashmole 242 is a folio volume of assorted papers, mostly astrological, some of them already discussed above in section II.8. The most interesting parts are the astrological and meteorological diaries and prognostications for the years 1608 and 1609 (ff.20 sqq.) by Sir Christopher Heydon. The volume also, as it happens, includes Heydon's *An Astrological Discourse* – a manuscript that was to be published thirty years after its author's death, by Nicholas Fiske in 1650, with Ashmole's help.[368] It is in the unpublished 'diaries' of Heydon that we find the eight-house figures.

Heydon's diaries begin conventionally enough, and at first (in 1608) we find him using the style (e) of our Fig. 1 in his text, turning to (d) for specific meteorological prognostications. As between 1608 and 1609, his style changed, and now we find figures in the form of the adjacent diagram (Fig. 31), in which the small central square is occasionally filled with a man-in-the-Moon. Fortunately Heydon included traditional twelve-house information in tabular form later in the work for the very phenomena covered by the eight-house figures, and we may compare data. As an example, take the full moon of 1609 June 7 (London, lat. given as 51;32°, long. as 24;15°). Planetary positions may be ignored here; they were said to have been obtained from Tycho Brahe's tables.

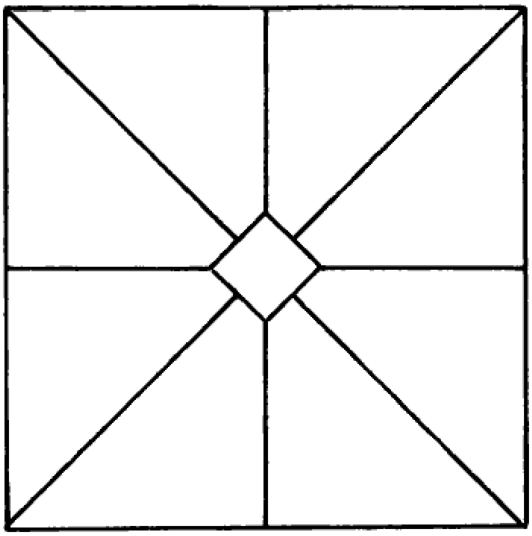

Fig. 31 Heydon's eight-house figure (c.1608).

In the following table, information from both parts of the work has been coalesced in the first two lines.[369] In other words, the longitudes with numerical subscripts (first line) give the scheme for the eclipse on the old twelve-house system (but by an as yet unknown method), while the longitudes λ_{10}, λ_l, λ_1, and λ_b give in the second line all the essential information about the drawn eight-house scheme. (In both cases, of course, the other cusps are found by adding 180° to each figure in turn.) Data below the first two lines will be explained shortly.

	λ_{10}	λ_{11}	λ_l	λ_{12}	λ_1	λ_2	λ_b	λ_3
12-hse	71;13	112		143	165;41	187		214
8-hse	71;13		114;36		165;41		211;45	
E	71;13	112;19	129;03	142;57	165;41	187;08	199;20	213;42
S	71;13		116;13		165;41		210;21	
P	71;13		114;36		165;41		211;45	

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[368] The MS had been in the possession of Richard Forster, President of the College of Physicians, and there is a letter from Heydon to him dated 1607.

[369] The data come from ff. 42v and 53r.

In the third line (labelled E) are given accurately calculated cusp longitudes for both schemes on the Equatorial (fixed boundaries) method, which we might imagine would have been used at this period of history in England. As will be seen, there is an excellent fit for the twelve-house horoscope, which is therefore in the Regiomontanus tradition. The computational procedure adopted for the intermediate cusps of the eight-house example (E) will be as explained in connection with Thomas Fink's horoscope B – the procedures of I. Will be modified so that the steps of 30° there will here be replaced by angles in steps of 45°. It is plain that this procedure was not used by Heydon. A quotation I am about to give from his work might have led us to expect something along lines that were generally acknowledged ancient, so in the above table, line S, I have quoted cusp longitudes based on an analogy with the Standard method of division (bisecting the cardinal arcs of right ascension, rather than trisecting them). These are close, but not close enough, for we can see that Heydon was a skilled calculator. In the last line, therefore, I have given values for the cusps by analogy with the Prime Vertical (fixed boundaries) method, and at last we get identical results to Heydon's. (As to the analogy, my remarks on the Equatorial method could be repeated.)

Here is what Heydon himself tells us of the eight-house concept, and how he came by it. He is commenting on a table with data for many astronomical events – all, it should be said, as accurately evaluated as the material we have been considering.

> The first [column] representing the positions of Heaven, at the Coniuncious, Opposicious, & Quarters of the Lights for every moneth in Octogonall figures, In the choise of which forme, rather then the Duodenary division, I am neither destitute of Example nor reason from tryed experience. The discourse hereof is improper to this place, though here I will not conceale that the ground hereof is originally borrowed from Ptolomies words, Lib:2:Quad:Tex.63. To the obscurity of which Cardan added some Light, but Tycho and Finkius more; by which chiefely I was incouraged to trie this forme, which shall for this tyme satisfie the Reader, that I obtrude no voluntary novelties of myne owne, and withall to give him an appetite to search further into the mystery thereof as it deserveth . . .[370]

It appears, therefore, that Heydon, far from claiming to have developed a new type of figure, believed that he was penetrating the obscure text of Ptolemy's *Tetrabiblos* with the help of three latter-day commentators, Cardan, Tycho Brahe, and Thomas Fink. Thomas Fink had indicated that there were those who ascribed the Dual Longitude method to Ptolemy. Looking back, therefore, over our material (the references are given in Appendix 1), we find that we have no fewer than six different readings of Ptolemy's intentions. One cannot help feeling that if the science of astrology had been as empirical as its practitioners claimed, Ptolemy's opinion would not have been deemed to matter so much.

II.28. *Schemes for a scientific élite. Brouncker's sixteen houses*

Although the manuscript with his diaries was never printed, Heydon had introduced, as we have seen, the notion of an eight-house horoscope into England in the course of preparing his prognostication for 1609, that is, presumably, during 1608. Like so many of his contemporaries, he thought he had reason and experience on his side, in his excursions into astro-meteorology. In his preface to the diary for 1609 he made clear his distaste for 'Arabian impurities' in astrology, and his wish to use the purified art for essentially religious purposes. He cast an innovative eye over his subject, and singled out for admiration chapter 12 of Kepler's *Mysterium cosmographicum* (1596), and the new varieties of planetary aspects there introduced. Aspects are no concern of this monograph, but as for Arabian impurities, there is good reason for thinking, as we saw in section I.11, that they included the technique he ascribed to Ptolemy – albeit for a twelve-house scheme.

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[370] Ibid. (Ashmole 242), f. 34r.

Heydon's interests were of course by no means entirely confined to meteorological astrology, although that was the context of his eight-house schemes, and I have not seen them used in an English context for any other purpose. The chances are that among the large collections of seventeenth-century astrological material surviving, which I have investigated in only the most cursory way, the eight-house system was used for nativities. The reason for thinking this to be so is that a *sixteen*-house figure survives from the last quarter of the century.

This figure occurs in an extremely interesting Bodleian manuscript, MS Aubrey 23, which is in fact a *Collectio geniturarum* (as its title has it) containing upward of a hundred examples brought together by John Aubrey. It is dated on the cover '1677'. The material is largely included in Andrew Clark's edition of Aubrey's *Brief Lives*[371], but without the figures and related astronomical material. It includes many valuable indications of contemporary practice. On the title page, for instance, he shows that he has been recommended to 'Get Naybod on Alcabitius' (cf. section above), while later (f. 8r) he writes 'vide Titus Placitus, de Astrologia much commended by Mr Is. Partridge' (cf. section I.16 for Placido's role in the spread of the Hour Lines (fixed bounds) method). The history of seventeenth-century astrology in Britain is usually seen today as a popular movement, flourishing in response to political and religious unrest, and promoted by men somewhat beyond the fringe of scientific respectability. Thus there is absolutely nothing surprising in the inclusion of horoscopes for Kenelm Digby or John Dee, in Aubrey's collection; and it is easy to accept that such men of letters and civil life as Robert Burton, John Dryden, John Evelyn, Matthew Hales, Titus Oates, William Penn, and Anthony Wood, should have had more than a passing interest in their own nativities, and 'revolutions' based on them (cf. section II.6 for this idea). What is more intriguing is the frame of mind of such ostensibly hard-headed thinkers as Thomas Hobbes, Walter Charleton, Robert Hooke, Edmond Halley, William Petty, and Christopher Wren – all but Hobbes, in fact, being fellows of the Royal Society, and not the least of its ornaments. There is, of course, no knowing how closely involved were these men, as subjects, with the casting of the figures, but there is reason to think that they were not exactly reluctant subjects. Thus it was evident from Aubrey's note on Charlton's figure (to be considered in detail shortly) that it came from the man himself: his birth was about 6 p.m., his mother being then at supper. Edmond Halley's nativity 'I had from Mr Hally himselfe' (f. 28v). It may be summarized as (313250), for 29 October 1656, London. Thomas Hobbes supplied at least the year, month, and day 'from his own mouth' (f. 52r). His was (020278) for 5 April 1588, Westport near Malmesbury. On Sir Christopher Wren, 'Surveyor of His Majesty's Buildings', we are told that 'the bell rang VIII, as his mother fell in Labour with him – from himselfe'. He was (097333), for Knoyle, near Shaftesbury, Wiltshire, on 20 October 1631. More to the point: Aubrey had obviously been discussing his material with Hooke, who provided him with information about the timing of the knighting of Wren the day after the event (f. 53r).

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[371] J. Aubrey (A. Clark ed., 1898), *Brief Lives, chiefly of contemporaries set down by John Aubrey between the years 1669 and 1696.*

These trifles tells us a little about the tenacity of astrological belief – and indeed, of the continuing popularity of the Equatorial (fixed bounds) method in the 1670s in England, for all, apart from one of the horoscopes for Charleton, turn out to have been cast on that basis. Thomas Sprat's history of the Royal Society might have expressed hostility to astrology, but it was in reality the theologians and satirists who did most to discredit the subject. It is ironical that Samuel Butler's *Hudibras* was in the course of appearing when Aubrey was putting together these evidences of judicial astrology within the elite of the Royal Society. (The first part of *Hudibras* came out in 1663, the second in 1664, and the last in 1678.) As a symbol of the Society's failure to take a lead in the attack that was slowly gathering momentum – and there is no censure implied here, of course – I shall end with a horoscope prepared by the future first President of the Society for a man who was to become President of the College of Physicians. It happens to be of great interest in its own right.

The horoscope is that set by Brouncker for Charleton, and now included in MS Aubrey 23. As Aubrey has added, in red ink, 'This is my Lord W^{m} Brounckar's doeing, & is his owne hand-writing' (f. 54v). William, second Viscount Brouncker (1620?–1684), had studied mathematics at Oxford, where he was created Doctor of Medicine in 1647. He has a number of mathematical achievements to his credit,[372] and was no hollow aristocratic figure-head at the Royal Society.[373] Walter Charleton (1620–1707, and thus a close contemporary of Brouncker) was another Oxford graduate in medicine. He was for long royal physician, and is now found interesting not least by dint of his Gassendist views on atomism. As he is only the subject of Brouncker's work, he is of less interest to us.

To be exact, the Brouncker item, beautifully penned, contains *two* nativities for Charleton. The second (f. 54v) is done on a common style (e) figure (Fig. 1) '*juxta modum Rationalem*', that is according to the Equatorial (fixed bounds) method. The ephemeris of Kepler is acknowledged for the planetary positions. Here are the cusps as recorded in this horoscope:

λ_{10}	λ_{11}	λ_{12}	λ_1	λ_2	λ_3
132;23	167;03	191;00	211;42	235;03	269;03.

Information in the central square repeats that in the first horoscope, from which we learn that it is for 'Dom G.[ualterus] Charleton D.M. nasc. ☿ $\frac{2}{12}$ Feb. A. Æ C. 1619/20 H.12. M.18. P.M. T.A. Shepton-Mallet El.P.51.12′ T. 2 10′ Lond.' He was born on a Wednesday (as the Mercury symbol indicates) 12 February 1620 by our modern way of reckoning (Gregorian, or 'New Style', with a January year beginning).[374] The latitude of Shepton Mallet is in fact 51;05° and its longitude from central London about 2;20°W, so Brouncker's value for the first is not particularly good; but as for the second, we have moved into a new age, when longitudes were reasonably well known. The statement in the colophon goes on to say that in matters of the equation of time the writer had used the *Almagestum novum* of Riccioli, while he has used Kepler for the planets. The work of Riccioli comprises perhaps a million and a half words, but scarcely a hundred of them are of an astrological cast. Since it appeared in 1653, this puts a *terminus ante quem non* on the undated document. Underneath it there are astronomical events recorded at various intervals from the birth date (after 21^d, 24^d, 31^d, 34^d, 21^y, 24^y, 31^y, 34^y), the latest being thus for 1654. It seems probable, therefore, that this was the approximate date of the document, and that the two men were then in their middle thirties, rather than their respectable old age.

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[372] For example, he made good use of continued fractions (introduced to mathematics by Cataldi in 1613), and he effected a quadrature of part of the equilateral hyperbola.

[373] He was, though, the King's nominee for President of the Royal Society (an office he held from 1662–77), and was elected unopposed. He was also President of Gresham College (1664–67).

[374] The DNB gives 2 February 1619, and the DSB 13 February 1620, both without qualification.

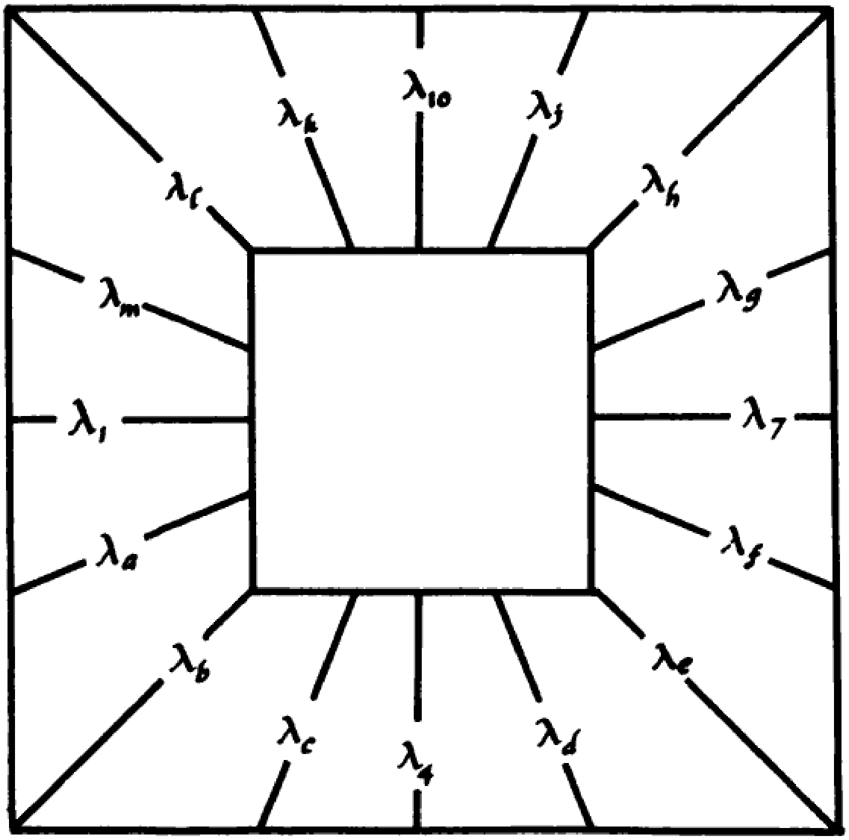


Fig. 32 The general style of Brouncker's sixteen-house figure, to which the notation used in the present text has been added.

The horoscope has sixteen houses distributed radially around the square, and is said to be '*juxta modum novum B.*'. One slight oddity is that the longitudes of the cardinal points are not quite the same on the two horoscopes, but of course the chief interest in the first from our point of view is the mathematical system by which Brouncker computed it. And who was 'B.', the astronomer with the new method? The cusps are recorded in the table below, and the accompanying figure (Fig. 32) shows the notation adopted (and from this it will be obvious why that of the last section was chosen).

λ_1	λ_a	λ_b	λ_c	λ_4	λ_d	λ_e	λ_f
222;40	242;02	269;03	299;18	328;28	353;24	13;14	28;33
222;40	240;14	263;52	295;35	328;28	352;48	12;19	27;38

The entries in the second line of the table are calculated on the method that seems to me to fit best with the horoscope, namely the analogue of the Equatorial (fixed bounds) method, now for sixteen houses instead of twelve. The steps in the calculation requiring increments previously of 30° now require increments of 22;30° – the idea should be plain from the previous section. The alternative analogues are much inferior. To give a comparison for λ_a alone: the Hour Lines (fixed bounds) method gives 234;13°, the Prime Vertical (fixed bounds) method gives 250;46°, and the Standard method gives 239;48° (although this seems tolerable, the other houses diverge greatly). These comparisons are made on the basis of an obliquity of 23;30° and a latitude of 51;12°, with λ_{10} assumed as a datum (and not λ_1, which agrees, however, exactly with Brouncker's figure). The calculation by Brouncker (if I am right in supposing it to have been arrived at as explained) seems to have been done less accurately than Heydon's, of section II.27, but notice that the two were using different techniques, for all the apparent relatedness of their schemes. We recall that Heydon, like his sources, used the analogue of the Prime Vertical method.

'*Juxta modum novum B.*'. May we asume that this was Brouncker's own method? I have found no explanation of it, in print or in manuscript, but perhaps it will eventually come to light elsewhere with an author's name. Tycho Brahe is obviously not 'B.', unless he took another step beyond his eight-house figures. Contemporary astronomers with the same initial include Boulliau and Borelli, and there are well over a score of British almanac makers in the seventeenth century with initial 'B' who might be seen as candidates. As has so often been the case in the present monograph, I have preferred to illustrate points of principle rather than attempt to achieve anything approaching comprehensiveness. I am happy to leave to others the task of showing that Brouncker, the man who was to become the Royal Society's first President, was not himself the inventor of the elaborate sixteen-house Equatorial (fixed boundaries) horoscope.

APPENDIX 1

Table of Historical Ascriptions

This table is meant to help resolve some of the standard historical confusions of terminology, some of them very ancient. It is not comprehensive. The names of the main methods across the top of the table are more fully explained elsewhere – see especially pp. 46–7. The names down the left are the earliest references found to, or supposed authors of, those methods, and the numbers in the body of the table are page references (again, not comprehensive) to places where the ascription will be made or found mentioned in the text. In other words, this is not only a table of claims to prior invention. Note that the '5° variants' are not taken into account.

	Hour lines (fixed bds.) method	Single longitude method	Equatorial (moving bds.) method	Equatorial (fixed bds.) method	Prime Vertical method	Dual longitude method	Standard method	Eight-house (Pr. Vert.) method
The Ancients/Porphyry						33		
Hermes					61			
Ptolemy	21 61	21	45	44		180		180
Firmicus		45						
al-Qabīṣī							24	
al-Bīrūnī					33			
al-Ghāfiqī				61				
Abraham b. Ezra	24							
Roger of Hereford					40			
Campanus of Novara					29			
John of Saxony							24	
Gin Gazul					29			
Regiomontanus				27				

APPENDIX 2

Two Fifteenth-Century Geographical Lists

The two lists of latitudes and longitudes of towns, conflated and reproduced below, are included here primarily as a guide to some of the latitudes that might be expected to reveal themselves in horoscopes. It would not be unduly difficult to supplement them from other sources, but there is a law of diminishing returns in these matters, and by restricting ourselves to two sets of data we may see more clearly what is shared and what are the differences between lists made at opposite ends of Europe – namely in England and Italy. They are unusually long, by European standards (but there are many longer, especially in the Eastern Islamic world). They illustrate extremely well the astonishing corruption, both of names, in many cases European names, and of coordinates, which we are often able to compare with the probable source. The lists even offer evidence that Europeans were accepting certain coordinates for their own cities that came from distant Eastern sources.

The earlier of the two lists is from Bodleian MS Laud Misc. 674, ff. 73r-74r, where it is found among a number of other tables by William Worcester (on whose work see, for example, North (1976), vol. iii, pp. 238–70). The leaves containing the table are dated April 1438. The manuscript is very small, and minutely written, and the list is contained in only three pages of the volume. This fact entails occasional difficulties in reading the script, but in the original the list is alphabetized for the most part (here it is rearranged by ascending latitude of place), so that we may be certain at least about initial letters. It will be seen from the various names given, for example, to Isfahan and Kabul how misleading late medieval orthography could be. It was not simply a question of transliteration; the scribes mistook even their own letter-forms, because the names were meaningless to them in so many instances.

Places on the first list are here numbered separately from those on the second, and the two are denoted by the letters W and I respectively. (The main abbreviations are listed below.) The second list is Italian. It is found in a Paris MS, Bibl. Nationale Lat. 10263, ff. 121r–124v, and is followed by comparable lists of towns giving their astrological characters (which I have here ignored). In fact earlier in the same MS there is a standard Toledan list. There are a number of indications in the MS (which contains many valuable astronomical items) that it was written around the year 1475. It is curious in one respect: it includes a shadow table and other material for the 'province' of Oxford. The writer knew precious little about northern lands and latitudes, as may be seen from the coordinates below. It is possible that the link with the Oxford material might be 'Roberto de Bardis de Florentia', who a century and a half before had held an appointment in Glasgow, and to whom John of Lignères addressed an astronomical work (see item 6, and North (1977)).

William Worcester was clearly an assiduous collector of data, and equally clearly he was interleaving (presumably using alphabetized slips) material from several different sources. I have not attempted to disentangle the different classes of material, and this is in no sense a critical edition of either his, or the Italian, work – which was likewise alphabetical, but did not involve so much duplication. There is much to be done on this kind of material, which, studied intensively, might well reveal hitherto unsuspected connections between Europe and the East. The blending of local traditions with oriental elements, however, is what gives the two lists much of their colour. The native British tradition evident in W goes back to the twelfth century at least. The Tuscan tradition which has yielded so many reasonably accurate latitudes for local towns is likewise old, but one has the feeling that many if not most of the Italian figures were relatively new.

The authors of W and I were evidently not aware of the identity of many of the places they were listing: compare 'Thebiri' and 'Echerus' (both for Kabul) and the reason will be obvious. Since William Worcester, at least, included many sets of coordinates for places he knew (as for Paris, for instance), it is obvious that he was aiming to produce a compendium as comprehensive as possible. The author of I was probably unaware of, and did not wish to make, duplication.

We find what we should expect in the longitudes: highly unreliable data, with two or more origins of coordinates – again, a thorough study would be needed to classify the material in this way. The latitudes are, on the whole, reasonably good, but there is an admixture of poor values that have nothing to do with miscopying. The latitudes for places in Britain (in W) reveal a mixture of older traditions (Hereford, Winchester, etc.) that had long been accepted, but that deserved revision. Roger of Hereford clearly had no successors in his art. Data from active British centres, such as London, Oxford, and St. Albans, like much of the Tuscan material, are generally good.

Some of the most interesting entries relate to high northern latitudes – say the eight or nine sets of figures from north of Berwick on Tweed. At first sight, one is tempted to think that some of these might relate to the tradition of the English friar (whether Nicholas of Lynn or another) who travelled with his astrolabe to arctic regions. Note the port of Lynn on the list. On closer scrutiny, however, the illusion tends to evaporate. Some of the information (for Caithness, for instance) is specific, although not very accurate, but other entries must stem from eastern sources. As Professor E. S. Kennedy tells me – and most of the following remarks are from him – Sacaliba is evidently from the Arabic al-Ṣaqāliba, the name for the Slavs ('the ignorant ones' was the usual qualification). Latin writers seem to have picked up the usage, for Saccaliba is in *Orbis Latinus* as denoting the region in the neighbourhood of Estonia. The latitude given for Thule by al-Tūsī and Ulugh Beg is that of W213. Ulugh Beg has no mention of a frozen sea, but for the latitude in W215, and a longitude of 27;30, he says that this is a place 'not inhabited'. Again, it seems likely that what is happening is that old data are being invested with new associations. One can hardly deny that those living in Britain knew of the northern islands, as far as Iceland, at least, and for this reason I have added a few indications of potential identifications for 'Ultima Thule', but they should not be taken to imply that there was necessarily any such conscious identification on the part of the original compilers. As for Civitas Magos (or Magog – my microfilm scarcely allows one to distinguish between the form of *g* and *s* in I), it does not look much like the biblical land of Magog (usually taken to be in Armenia). The latitude and longitude would put it somewhere in the land of the Lapps, where there are no towns worth the name, yet at the flick of a pen it can be brought back to civilized latitudes. I owe many of my brief references to the joint efforts of Professor Kennedy and Dr Reinhard Wieber of Bonn, and they remark that they have numerous examples of coordinates for the biblical and Qūrānic Gog (Jūj) and Magog (Majūj), but these are invariably for north-east Asia, north of China. They can offer the equivalent of I's latitude, but his longitude is garbled. Gog and Magog are plotted on Idrisi's map, for instance.

Dr Wieber has found in a Muslim geographical work reference to a place in the far north-west so cold that the people keep warm in the underground hot springs – evidently a reference to Iceland (cf. W 214). He also notes (cf. W 214) Khwārizmī's place at latitude 60 and longitude 36;40, 'the land of *Gharmaniya* (Germany), it being in the country of the Ṣaqāliba'. Note too his remarks about I 179, 181, W 211 and 97: the first three have the same coordinates as Khwārizmī's Tālā, and according to a reconstructed Khwārizmīan map become a city in Ireland, and not (as the coordinates might lead us to believe) the Orkneys. This observation raises the problem of what we are saying when we claim that an entry represents such and such a place. In my all too brief notes (anything longer would have been gratuitous in the present context) I have tried to hint at potential sources, but each entry could in this respect be the subject of a whole chapter. It is quite clear, throughout, that the entries take on a life of their own, or rather many lives. They become garbled, the numerals are miscopied, and similar place-names are substituted for the unfamiliar. Source meanings and philological connections are not always the most important guide to semantics. What is more surprising, however, is that so many of the poor *local* coordinates still being quoted in medieval manuscripts were derived from writers distant both in time and space.

In rearranging the original lists, I have tried to make them usable for our present purposes. They are naturally deficient in German, and even Spanish and French, places. I have omitted entries from W where no latitude is stated – in most cases there is then no longitude either. The entries are few, and are as follows (with longitudes in parentheses where given): Andegave (Angers); Cambridge (16;48); Edinburgh; Glastonbury; Paris; Berberno; Britannia Minor (i.e. Britanny).

Finally, on the subject of the much richer Islamic tradition, it may be mentioned here that Mary Helen and Edward Kennedy have a collection of place-names with coordinates running to over 12000 entries (on magnetic tape and disc). Naturally, few places in northern Europe appear on it. As examples of how some of their figures have entered European usage: the poor latitude for Pisa in W 125 is in al-Kāshī (but with longitude 47;00); aṭ-Ṭūsī and Ulugh Beg have 'Britain, farthest south' for the latitude of w 161; and for W 128 they give the island of Misiliya (?). Marseille is hardly an island, but it seems likely that it was associated with this.

A full bibliographical key would be as long as the lists themselves. The following list of abbreviations should make it possible to track down sources, with the help of such works as Toomer (1968), the *Encyclopedia of Islam*, the *Isis Critical Bibliography*, the works of F. Sezgin, and so forth:

A – *Kitab al-Aṭwāl*; Ash – the Zīj-i Ashrafī; B – al-Battāni; Ba – Ibn al-Bannā'; Bg – al-Baghdādī; Bi – The *Taḥdīd* of al-Bīrūnī; HT – *Handy Tables* of Ptolemy; JE – Jacob of Edessa; K – al-Kāshī; KH – al-Khwārizmī; M – al-Maghrībī; Pt – *Geography* of Ptolemy; QBL – *ma'rifat al-qibla* by al-Dimyātī; S – ibn Sa'id al-Maghrībī; Sa – *az-Zīj li-ṭūl San'a*; Sha – Ibn ash-Shāṭir; Su – Suhrab (ibn Serapion); TT – Toledan Tables; Yu – Ibn Yūnis; Za – the Damascus Zahiriya.

Lat.	Long.	Place-name in MS.	Modern name	Further comments		No.
00;00	090;00	Arin	from 'Ujjain'	orig. of prime merid.	W	1
00;00	000;00	Paradisus	(W. prime merid)	'Isles of the Blest'	W	2
00;00	072;30	Arim			I	1
00;00	070;00	Baldach			I	2
03;00	125;30	Cerendin	Ceylon	Ar. 'Sarandīb'	W	3
03;00	125;00	Cerendin	Ceylon		W	4
03;31	047;00	Barcha	Barqa (el-Marj)	erron. lat. (cf. 31;00)	I	3
04;00	123;00	Dancich (?)			I	4
04;00	063;00	Kavach			I	5
04;00	107;00	Taphalla			I	6
05;00	125;00	Famzui (?)	Bafficalia(?)	Ar. 'Farsaqurī'	I	7
06;00	127;00	Bohelmi et insula			I	8
06;00	121;00	Megat	Majunūn(?)		I	9
08;00	129;00	Mautaria	Ma'ariya(?)	coords as QBL	I	10
09;00	121;00	Belim			I	11
09;00	087;00	Civitabzuz (?)		'City on the island of Muyd'	I	12
10;36	015;30	Canah	Ghana		W	5
10;45	015;30	Granata	Ghana	coords of TT and Yu	I	13
10;45	015;30	Tanab			I	14
11;00	003;00	Manna			I	15
12;00	076;00	Ceretgh			I	16
12;00	125;00	Gez de Terra Indie			I	17
12;30	071;00	Alramarach	Hadramaut	cf. Adramauth (Khw.)	W	6
12;30		Adcamahuk		prob. as preceding	W	7
12;30	071;00	Adamant		cf. the preceding	I	18
13;00	032;00	Amedia, i.e. Africa	Mahdia (Tun.)	erron. lat. (usu. 36°)	I	19
14;00		Sanahans	Sanaa		W	8
14;00	129;00	Mavira		Mondura in HT (lat. 16;20)	I	20
14;30	053;00	Civitas Amba	Dongola (Nubia)	Civ. Anuba in TT	W	9
14;30		Sandan	Sanaa		W	10
14;30	063;30	Sanria	Sanaa	coords of TT	W	11
14;30	053;00	Amba	Dongolia (Nubia)	cf. TT and W	I	21
16;00	064;00	Cabeth		coords of al-Mahum(?) in S	I	22
18;00	117;00	Bems (?)		Bithane of Pt, HT(?)	I	23
18;00	086;00	Fragum		coords of al-Zanj in QBL	I	24
18;00	068;00	Machara			I	25
18;30		Asperion			W	12
18;30	137;00	Civitas regis Acim	city in China	long 117;00 in TT	W	13
18;30	159;30	Civ. Regni altra		cf. preceding ?	I	26
18;30	159;30	Civitas Regis		cf. two preceding	I	27
19;00	177;30	Achim	China	Yu has 'as-Sin'	W	14
19;00	169;00	Alperion		cf. lat. 18;30	W	15
19;45		Bamen	Oman	Hamen in TT	W	16
19;45	084;30	Homei	Oman (cf. prev.)	common variant sp.	W	17
20;00	020;00	Amoni		corrupted preced. ?	I	28
20;00	107;20	Bugarde			I	29
20;00	044;00	Crachava			I	30
20;00	044;00	Orana		cf. coords I 30	I	31
20;24		Thebatyn		Wadi Halfa ?	W	18
20;30		Cebil		Kabul? cf. lat. 28;00	W	19
21;00	021;00	Iurgen			I	32
21;00	067;00	Mecha	Mecca	coords as TT	I	33
21;40	067;00	Mecah	Mecca	cf. preceding	W	20
22;00		Ragessinium		cf. following	W	21
22;00	050;00	Se()ganessa (?)	coords Mecca (Bi)	cf. 'Sigil Messaha' in TT	W	22
22;00	015;10	Bagosinum	cf. preceding	long. 15;00 in TT	I	34
22;00	015;00	Balgesim (?)	cf. previous	these are TT coords	I	35
22;00	022;00	Civ. Reg. Magistrorum	'place of the king' (A)	'city of king of China' (K)	I	36
22;00	125;00	Cequi		rel. to Cerendin ?	I	37
22;00	054;00	Damiata	Damietta	erron. lat. (31° TT)	I	38
22;12	015;30	Canah	Ghana	usu. lat. 10;36 (q.v.)	W	23

Lat.	Long.	Place-name in MS.	Modern name	Further comments		No.
22;30	056;00	Assuen	Aswan	coords as TT	W	24
22;30	050;00	Asuem	Aswan	cf. preceding	I	39
22;45		Granad			W	25
24;00	063;30	Algaiz	Medina (al-Jar)	coords as Bg	W	26
24;00	064;20	Amedia	Medina ?	cf. prev. and next	I	40
25;00	065;20	Abnedine	Medina	Almedina in II	W	27
25;15	006;30	Tangea	Tangier	lat. error; see 35;15	W	28
26;00		Corsini			W	29
26;20	056;00	Alzum	Kolzum ?	cf. lat. 28;30	I	41
28;00		Chebil	Kabul	cf. following	W	30
28;00	100;00	Thebiri	Kabul	'Th' from 'Ch', etc.	W	31
28;00	100;00	Echerus	Kabul	cf. prev. comment	W	32
28;00	100;00	Thebiru	Kabul	cf. Thebiri	I	42
28;09	100;00	Cebeb, i.e. Chebiz	Kabul	cf. prev. corruptions	I	43
28;30	056;30	Alizum	Kolzum (Egypt)	lat. 28;20 in TT	W	33
29;00	055;00	Fugica Egipti	Cairo	cf. lat. 30;00	I	44
30;00		Messeia Egipta	Miṣr (Cairo)	also name for Egypt	W	34
30;00	110;00	Alcaudegar	Kandahar	Kh, Bg, Su coords	I	45
30;00	130;00	Alberti	Tibet	Albeit, lat. 38° (TT)	I	46
30;00	055;00	Babilonia Antigua	Cairo	contrast lat. 33;20	I	47
30;00	066;30	Gerarda	Gerasa	near woods in Pt	I	48
30;00	048;30	Kaladuquia			I	49
30;00	055;00	Messina	Cairo (Miṣr)	coords as Yu. See W34	I	50
30;06	054;00	Egiptus	Cairo (Miṣr)	long. as Bu (lat. 30°)	I	51
30;18		Alexandria	Alesandria	TT lat. 31;00	W	35
31;00	051;20	Alexandria	Alexandria	as in TT	W	36
31;00		Alborzia	Basra	long 74;00 in TT	W	37
31;00	055;40	Ascalon	Ascalon	TT lat. 32;00	W	38
31;00	074;00	Albesra	Basra	coords as TT.	W	39
31;00	047;03	Barcha	Barca (el-Marj)		W	40
31;00	054;40	Teniz	Tinnis (Egypt)		W	41
31;00	007;00	Aion (?)			I	52
31;00	051;20	Alexandria Egipti	Alexandria	coords as TT	I	53
31;00	083;00	Civitas Venti			I	54
31;00	015;00	Covith (?)			I	55
31;00	083;00	Cuitab (?)		cf. Civitas Venti	I	56
31;00	054;00	Daumat	Damietta	cf. below	I	57
31;00	012;00	Ita			I	58
31;00	075;00	Ior	Abadan (Ash,Sh)	Ahwāz (Su), Baṣra (Ash)	I	59
31;00	039;30	Messana	Messina	PT has lat. 38;30	I	60
31;20	051;20	Burgi nova	Alexandria?	Kh has lat. 31;05	I	61
31;25	054;09	Damiata	Damietta	31°, J4° in TT	W	42
31;25	058;09	Damiata	err. for Farama?	TT coords for Farama	W	43
31;30	055;40	Alcarme	Carmel (name)	err. for Farama?	W	44
31;30		Assueri	Le Kef (Tunis)?	usu. Assuras (36°)	W	45
31;30		Carmelus	Carmel (name)	lat. of Farama ?	W	46
31;30	055;56	Almarnich	Farama		I	62
31;50	069;30	Alcufa	Kufa		W	47
32;00	056;00	Jerusalelmus	Jerusalem	TT coords	W	48
32;00		Radec	Baghdad ?	see lat. 33;15	W	49
32;00	006;00	Almasincha	Sijilmasa (N. Afr.)	see I64	I	63
32;00	026;00	Amuen (?)	Sijilmasa	coords as Za	I	64
32;00	055;00	Asclalom	Ascalon	coords as TT	I	65
32;00	056;00	Amarda	Ramleh	coords as Ya (cf. N50)	I	66
32;00	095;00	Balch	Balkh	cf. lat. 38;40	I	67
32;00	064;00	Cezeten	Ghazza (Pal.)	coords as QBL	I	68
32;00	054;00	Damascuz	Damascus	poor coords, cf. 33°	I	69
32;00	056;00	Iherusalem	Jerusalem	coords as TT	I	70
32;00	018;00	Kabaria	Gabès ?	coords as Mauretania	I	71
32;00	079;00	Lyebil	Istakhr (QBL)	Yezd (A), or Būrībiiri	I	72
32;15	056;00	Amela	Ramleh	coords as TT	W	50

Lat.	Long.	Place-names in MS.	Modern name	Further comments	No.	
33;00	060;00	Damascus	Damascus	coords as TT	W	51
33;00	057;00	Suratirus	Tyre (Ar. 'Ṣūr')	class. 'Sarra'	W	52
33;00	040;00	Trabilus Arabum	Tripoli (Libya)	coords as TT	W	53
33;00	060;00	Damascus	Damascus	coords as TT	I	73
33;00	062;00	Heunep	Ḥalab = Aleppo	33;30, 63;00 in Sa	I	74
33;00	009;00	Nescab	Ceuta ?	lat. 35;30 in S	I	75
33;00	057;00	Sire	Tyre (Ar. Ṣūr)	coords as TT and W	I	76
33;00	040;00	Trabulazar	Tripoli	cf. above	I	77
33;14		Sem	Tyre ?	cf. Sire & Sur	W	54
33;15	070;00	Radget	Baghdad	lat. 33;25 in TT	W	55
33;20	064;30	Babilonia		presumed the region	W	56
33;24	070;00	Bagdoch	Baghdad	TT lat. 33;25	I	78
33;25		Bandach	Baghdad	cf. preceding	W	57
33;25	070;33	Baradech	Baghdad	TT long. 70;00	I	79
34;30	075;00	Hispaen	Isfahan	cf. next 4 items	W	58
34;30		Ispalen	Isfahan	cf. above	W	59
34;30		Ispanel	Isfahan	cf. above	W	60
34;30	075;00	Yspacii	Isfahan	cf. above	W	61
34;30	076;00	Ispaen	Isfahan	as prev. items	I	80
35;00		Aquileia	A. in Ven. Gulf ?	HT was 34°, long. 45°	W	62
35;00	008;00	Cepta	Ceuta (Ar. Sabta)	lat. 35;20 in TT	W	63
35;00	008;00	Septa	Ceuta	cf. previous item	W	64
35;00	078;00	Babilonia Nova	presum. region	long. 19° in QBL, B, HT	I	81
35;00	008;00	Cepta	Ceuta	coords as W, not TT	I	82
35;00	028;00	Eduna (?)	Almería (Sidonia) ?	lat. ??° in M for Alm.	I	83
35;00	057;30	Ephesus	Ephesus (Turk.)		I	84
35;00	019;09	Eusonia		cf. Osonia	I	85
35;00	019;00	Kauseri		related to prev. ?	I	86
35;00	019;09	Osonia		altered from 19;04	I	87
35;09	064;30	Babilon	presum. 'novum'	cf. 35;30 and 35;00	I	88
35;20	077;00	Armenia	Lesser Armenia?	cf. lat. 41;00	W	65
35;30		Almosri	Mosul	cf. next item	W	66
35;30	069;00	Almasu	Mosul		W	67
35;30		Babilon novum	presum. region	contrasts with Cairo	W	68
35;30	031;00	Cirenen	Kairouan	now in Tunisia	W	69
35;30		Cirene	Kairouan	cf. above for long.	W	70
35;30	067;20	Antheochia	Antakya (Turk.)	Antioch	I	89
35;50	027;10	Cartago	Carthage (Tun.)	27;00 & 37;00 in TT	I	90
35;50	031;00	Cirene	Kairouan	long. 35;30 in TT & W	I	91
36;00	032;00	Affricha	Mahdia (Tunis)	Almedia of TT	W	71
36;00		Alragaz	Raqqa	cf. next item	W	72
36;00	073;36	Aracia	Raqqa		W	73
36;00	086;00	Fargarum	Farghana		W	74
36;00		Insula Livino	Lilybacum (sic)	long. of Lit. 37° in Pt	W	75
36;00		Insula Rodum	Rhodes	long. 58;40 in PT	W	76
36;00	038;00	Malta	Malta		W	77
36;00	068;00	Rodis Insula	Rhodes		W	78
36;00	000;00	Gades Hercules	Cadiz	'W. limit of habitation' (SE)	W	79
36;00	061;00	Ancaquia	Antioch	M has long. 71° for Ant.	I	92
36;00	074;00	Alucifra	Nuhāwand (Iran)	Kh's coords for Nuh.	I	93
36;00	086;00	Alre	ar-Rayy (Iran)	36;10, 87;20 in Za	I	94
36;00	052;00	Civ. Sapien in Persia	Athens (cf. PT) ?	not Persian long.	I	95
36;00	060;00	Cyprus	Cyprus	M has long. 63°	I	96
36;00	013;36	Maiorica	Majorca	misreading 13 for 38 (Ya)	I	97
36;00	038;00	Malacha	Malta	as in TT and W	I	98
36;23	054;40	Heraclia	Eregli	corrupt (cf. 46;35)	I	99
36;30		Sagesta	Zagreb ?	erron. lat. if Zagr.	W	80
36;50	107;20	Bucareb	Bokhara		W	81
36;50	107;20	Sucoreh	Bokhara	cf. prev. orthography	W	82
37;00		Cata	Carthage	cf. next item	W	83
37;00	027;10	Cratago	Carthage	nr. Tunis (cf. 35;50)	W	84

Lat.	Long.	Place-name in MS.	Modern name	Further comments		No.
37;00	037;00	Insula Morella	Pantelleria ?	Ptol. coords Palermo	W	85
37;00	009;20	Corduba	Cordoba	cf. 37;30, true 37;53	I	100
37;00	037;00	Insula Monzole	Pantelleria ?	cf. Morella (37;00)	I	101
37;00	039;20	Syracusa	Syracuse		I	102
37;30		Asre Ispaloen	ar-Rayy (Iran)	cf. 159–60, and W 90	W	86
37;30	086;00	Alre	ar-Rayy (Iran)		W	87
37;30	009;20	Corduba	Córdoba	cf. 37;00, usu. 38;30	W	88
37;30		Centorbium	Kenturipai ??	PT 37;50, 38;30	W	89
37;30		Ispalones	Ispalis = Seville	S has long. 9;10	W	90
37;30		Sibilia	Seville		W	91
37;30	025;35	Sybilia	Seville	M has long. 25;40	I	103
38;00	130;00	Albit	Tibet	TT coords; cf. 30;00	W	92
38;00		Albeit	Tibet	cf. prev. item	W	93
38;00	031;00	Insula Sardine	Sardinia	coords as TT	W	94
38;00	030;00	Maroca	Bizerte ?	Biz. 33;50, 33;35 (S)	W	95
38;00	029;00	Tuniz	Tunis		W	96
38;00	092;00	Flargana	Farghīna ?	erron. lat.	I	104
38;00	075;00	Ispalen	Isfahan	cf. 34;30 and 37;30	I	105
38;00	084;00	Maroch	Merv ?	Merv 33;35, 84;20 (Kh) ?	I	106
38;00	031;00	Sardinia	Sardinia	coords as TT	I	107
38;00	029;00	Tunisium	Tunis	coords as TT and W	I	108
38;10		Insula Tule	Orkney ?	lat. error (cf. 58;10)	W	97
38;16	060;00	Pannorim	Palermo	err. long., cf. foll.	W	98
38;16	037;30	Pasnormum	Palermo	class. Panormus	I	109
38;20		Messana	Messina	long. 39;30 (HT)	W	99
38;20		Saraculora (?)	Saracena (It.)	Saracenum Castrum	W	100
38;30		Mescana	Messina	cf. W99	W	101
38;35		Rembrot (?)	Merv-i Rūd ?		W	102
38;40	108;35	Balgh	Balkh	as TT	W	103
39;00	044;30	Bradisnum	Brindisi ?	if so, coords poor	W	104
39;00	036;00	Insula Cisilie	Sicily	coords as TT and I	W	105
39;00	041;00	Malchia			I	110
39;00	036;00	Sicilia	Sicily	coords as TT & one W	I	111
39;20	036;00	Cisilia	Sicily	contrast lat. 39;00	W	106
39;30	025;23	Britania	Brittany ?	confusion of coords	I	112
39;36	030;20	Valentia	Valencia (city)	lat. 37; 20 (M)	I	113
39;54		Ragen	Toledo	Tol. commonly 'Raben'	W	107
39;54	011;00	Toletum	Toledo	40;00 in TT	W	108
39;58	011;00	Toletum	Toledo	cf. prev.	I	114
40;00	087;00	Aditratam			I	115
40;00	025;00	Avinio	Avinyo (Sp.) ?		I	116
40;00	108;35	Balgeth	Balkh	err. lat. (cf. 38;40)	I	117
40;00	091;00	Cazar	Kunya Urgench ?	cf. Corarismi, 42;10	I	118
40;00	082;00	Trabazu	Tabaristān	coords as QBL. cf. I 125	I	119
40;10		Neapolis	Naples	long. often 36;38	W	109
40;10	037;00	Neopolis	Naples	lat. altered to 42;20	I	120
40;25		Ileys		from 'Lucania' ?	W	110
41;00	077;00	Armenia	Armenia	cf. foll., also 35;20	W	111
41;00	077;00	Armenia	Armenia	as in TT and Battani	I	121
41;00	075;00	Armenia	Armenia	cf. two items in W	I	122
41;00	038;00	Dalerim	Salerno ?	earlier miscopying ?	I	123
41;00	038;00	Salernum	Salerno	cf. prev. item	I	124
41;00	082;00	Trabatu		cf. Trabatu (40;00)	I	125
41;10	041;00	Capua	Capua	40;00, 41;20 in HT	I	126
41;20		Terra Chuum (?)	China ?	if Como, lat. erron.	W	112
41;20	040;30	Brundusium	Brindisi	39;50, 42;10 in HT	I	127
41;30		Cesar Agusta	Saragossa	long. 29;55 in QBL	W	113
41;30		Capua	Capua	cf. 41;10 (I)	W	114
41;30	023;00	Janua	Genoa	lat. poor, but as I	W	115
41;30		Reatum	Rieti	class. Reate	W	116
41;30	029;00	Ienua	Genoa	orig. 43;30, cf. W	I	128

Lat.	Long.	Place-names in MS.	Modern name	Further comments	No.	
41;30	031;00	Loida (?)	Naples ?	coords of Naples in Kh	I	129
41;31	041;00	Beneventu	Benevento	lat. 41;20 in HT	I	130
41;34	069;00	Messie	Messina ?	coords in some copies TT	W	117
41;40		Synay	(Mt.) Sinai ?	if Mt. S., lat. erron.	W	118
41;50	035;25	Roma	Rome		W	119
41;50		Rebic			W	120
41;50	035;25	Roma	Rome	coords as TT and W	I	131
41;51	008;00	Euguda (?)	Merida	cf. 41;55 (W as TT)	I	132
41;55	008;00	Emerida	Merida (Sp.)	coords as TT	W	121
41;55	008;00	Rinerida	Merida	cf. 'Emerida'	W	122
42;00	086;00	Fargarum	Farghana	42;20, 92;00 in Kashi	W	123
42;00		Narbona	Narbonne (Fr.) ?	long. 21;30 in HT (cf. I 140)	W	124
42;00	033;00	Pise	Pisa	cf. 43;30	W	125
42;00	045;00	Ameza	Rhizana ?	42;00, 45;15 in Pt for R.	I	133
42;00	091;50	Corosin	Kunya Urgench	cf. 42;10	I	134
42;10	091;50	Corarismi	Kunya Urgench	as in TT	W	126
42;30	033;25	Florencia	Florence	Pt has 43;00, 30;50	W	127
42;30	032;30	Bononia	Bologna	Pt has 43;30, 33;30	I	135
43;00	036;15	Ancona	Ancona (It.)	Pt has 43;40, 36;30	I	136
43;00	040;00	Ancona	Ancona	altern. reading	I	137
43;00	059;00	Ancato	Ankara ?	long. 58° in Kh for Ank.	I	138
43;00	092;00	Fargana	Farghana	cf. 42;00	I	139
43;00	025;00	Narbona	Narbonne (Fr.) ?	cf. 42;00	I	140
43;00	034;20	Perusium	Perugia	long. 35;20 in Pt	I	141
43;10	033;25	Florentia	Florence	cf. 42;30	I	142
43;10	036;30	Firmum	Fermo (It.)	42;55, 37;30 in Pt	I	143
43;15		Mislis	Marseille ?	'Misiliya island' (K, Ṭ)	W	128
43;30	033;00	Pise	Pisa	(cf. W125) 42;45, 33;30 in PT	I	144
43;30	033;00	Pistorium	Pistoia	43;00, 33;20 in Pt	I	145
43;40		Constantini	Istanbul	usu. long. is 56;40	W	129
43;40	054;10	Constantinapolis	Istanbul	coords much altered	I	146
44;00	032;35	Bononia	Bologna	cf. (inferior) 42;30	W	130
44;00	027;00	Marcella	Marseille	43;05, 24;30 in Pt	I	147
44;04	014;00	Mons Pessulanus	Montpellier	cf. 44;40	I	148
44;06	030;15	Marcilia	Marseille	cf. 44;00, 43;15	W	131
44;24	033;30	Forlivium (?)	Forlì		I	149
44;30	034;00	Verona	Verona		I	150
44;40	028;00	Mons Pessulanus	Montpellier	prob. from 44;04, q.v.	W	132
44;50	030;20	Mediolanum	Milan	lat. altered to 41;00	I	151
45;00	049;00	Alconstancia	Istanbul	coords as in TT	W	133
45;00	056;40	Constantinapolis	Istanbul	contrast prev. item	W	134
45;00		Cremona	Cremona	cf. entry from I	W	135
45;00		Novaria	Novara	cf. entry from I	W	136
45;00		Ravenna	Ravenna	44;00, 34;30 in Pt	W	137
45;00	023;04	Vienna	Vienne (Fr.) ?	note long. 34;00 in I	W	138
45;00	081;00	Asoż	Khazar ?	long. 83° in Kūshyar	I	152
45;00	031;15	Cremona	Cremona		I	153
45;00	032;30	Ferraria	Ferrara		I	154
45;00	027;30	Marsilia	Marseille	lat. altered to 40;00	I	155
45;00	030;15	Novaria	Novara	W lacks long.	I	156
45;00	031;00	Placentia	Placenza		I	157
45;00	033;00	Pisse	Pisa ?	cf. 42;00, 43;30 (best)	I	158
45;00	034;00	Vienna	Vienne (Fr.) ?	note diff. long. in W	I	159
45;15	033;00	Rodes	Rodez (Fr.)		W	139
45;15	031;15	Clugia	Chiusa (It.) ?		I	160
45;15	031;39	Mantua	Mantua		I	161
45;15	029;30	Pesaurum	Pesaro (It.) ?		I	162
45;15	033;00	Venetie	Venice		I	163
45;24	031;00	Brissia	Brescia		I	164
45;24	032;30	Padua	Padua		I	165
45;30	029;00	Vicentia	Vicenza		I	166

Lat.	Long.	Place-names in MS.	Modern name	Further comments	No.	
45;45	032;45	Tarvisium	Treviso ?		I	167
45;50	023;45	Sedes Reg. Francorum	Lyon ? Reims ?	place & coords in TT	W	140
45;50	023;43	Sedes Regis	Lyon ? Reims ?	cf. prev. item	I	168
46;00	035;15	Aquilegia	Aquileia	45;00, 34;30 in Pt	I	169
46;35		Civitas Arsta (?)	Aosta ?		W	141
46;35		Eraclia	Eregli (Turkey)	class. Heracl. Pont.	W	142
46;35	053;25	Fracha	Eregli (Turkey)	coords as TT	W	143
46;35	053;25	Erachia	Eregli (Turkey)	see preced. items	I	170
46;50	033;25	Colonia	Noyon, L. Geneva	Colonia Equestris	I	171
48;00	067;00	Parisius	Paris	long. excessive	W	144
48;35	020;00	Parisius	Paris	48;30, 23;30 in Pt	W	145
48;40	023;00	Parisius	Paris	altd. to: 23;30, 45;50	I	172
48;50	040;30	Parisius	Paris	'secundum alium'	W	146
48;50	019;00	Lugdunum	Lyon	lat. altered to 45;00	I	173
49;06		Tholosa Alta	Toulouse ?	T. Aurea ? lat. v. high	W	147
49;06	023;47	Tolosa	Toulouse ?	44;15, 20;30 in Pt	I	174
49;20		Reims	Reims		W	148
50;00	022;34	Rove Castra	Rochester		W	149
50;00	028;20	Colonia	Köln		W	150
50;09	028;24	Maguncia	Mainz	50;15, 27;20 in Pt	I	175
50;15		Wyntonia	Winchester		W	151
50;25		Wyntonia	Winchester		W	152
50;40		Doueria	Dover		W	153
50;50		Cestria	Chester		W	154
51;00		Exonia	Exeter		W	155
51;00		Sarum	(Old) Sarum	nr. Salisbury	W	156
51;00		Wight	Isle of Wight	spelt with yogh	W	157
51;00		Exonia	Exeter		W	158
51;10	023;00	Bursunt	Brussels ?		I	176
51;15	014;30	Bristollia	Bristol		W	159
51;30	063;28	Antiochia	Afyon ?	v. corrupt (cf. 35;30)	W	160
51;30		Britannia	Britain	Arab lat. for S. Brit.	W	161
51;34	019;26	Londonia	London	usu. 'Londinium'	W	162
51;34	016;30	Londonia	London		W	163
51;34		Wyncestria	Winchester	lat. poor	W	164
51;34	016;00	London	London		W	165
51;36		Cantuaria	Canterbury		W	166
51;36		Cantuar	Canterbury		W	167
51;38	017;50	Villa S. Albani	St Albans		W	168
51;38		Villa S. Albani	St Albans		W	169
51;39	019;26	London	London		W	170
51;39	024;00	Madebrugen	Magdeburg ?		I	177
51;40	018;30	Colchestria	Colchester		W	171
51;40	059;30	Londonia	London	in margin	W	172
51;40	018;00	Colcestr.	Colchester		W	173
51;50	017;56	Oxonia	Oxford		W	174
51;50	015;00	Oxonia	Oxford		W	175
51;50	017;56	Oxonia	Oxford		W	176
51;50		Oxonia regio	Oxford	lat. given as long.	I	178
51;58		Dublonia	Dublin ?	error for Dunstable?	W	177
52;00	062;00	Oxonia	Oxford	margin (late)	W	178
52;10		Cesria	Chester		W	179
52;15	028;30	Thetford	Thetford		W	180
52;18	015;49	Cantabrigia	Cambridge		W	181
52;22	017;28	Norwicus	Norwich		W	182
52;22	016;47	Cantabrigia	Cambridge		W	183
52;30		Mirake (?)	Warwick ?		W	184
52;40	034;20	Lennia	King's Lynn		W	185
52;40	019;30	Norwicus	Norwich		W	186
52;50	017;46	Cloucestria	Gloucester	for lat. 51;50 ?	W	187
52;50		Herfordia	Hereford	lat. poor but usual	W	188

Lat.	Long.	Place-name in MS.	Modern name	Further comments		No.
52;50	019;40	Leycestria	Leicester		W	189
52;50	016;54	Northamptonis	Northampton		W	190
52;50		Northumbria	Northampton ?	name miscopied ?	W	191
52;50	019;40	Leycestria	Leicester		W	192
52;50	016;45	Norhampton	Northampton		W	193
53;00		Lyncolnia	Lincoln		W	194
53;00		Netingham	Nottingham		W	195
53;00		Stafford	Stafford		W	196
53;15		Evesham	Evesham		W	197
53;15	019;00	Lyncolnia	Lincoln		W	198
53;30	019;00	Eboracus	York	usu. 'Eboracum'	W	199
53;40	016;00	Stanford	Stanford		W	200
53;40	024;00	Herfordia	Hereford	for lat. 52;40 ?	W	201
53;40		Eboracus	York		W	202
54;00	019;00	Eboracus	York		W	203
54;01		Catanis	Caithness (Sc.)	diocese (poor lat.)	W	204
55;00		Novum Casorum	Newcastle		W	205
55;30		Scocie principium	Scottish border		W	206
56;00	017;00	Berwike	Berwick		W	207
56;50	019;00	Berwik	Berwick		W	208
57;00		Catanoisbri (?)	Caithness ?	Cataness bri(d)g(e)?	W	209
58;00		Villa S. Johannis		lat. near Dornoch	W	210
58;00	010;00	Insula Tile	in Ireland if Kh	prob. Kh's Tāiā (Thale)	I	179
58;00	019;00	Lodonia	London	I's north. lats. poor	I	180
58;10	010;50	Insula Tile	Orkney ?	Ultima Thule	W	211
58;10	010;00	Tibe.	Orkney ?	Thule, cf. W's long.	I	181
61;00		Insula Borea	Shetland ?	or Faeroes ?	W	212
63;00	010;50	Insula Tile	Shetland ?	Faeroes ? Iceland ?	W	213
64;30		Sacaliba	The Slavs	al-Şaqāliba (Ar.)	W	214
65;30		Mare gelidum	(frozen sea)	drift ice off Icld.	W	215
68;00	043;00	Civitas Magos	in Russia ?	City of Magog	I	182

APPENDIX 3

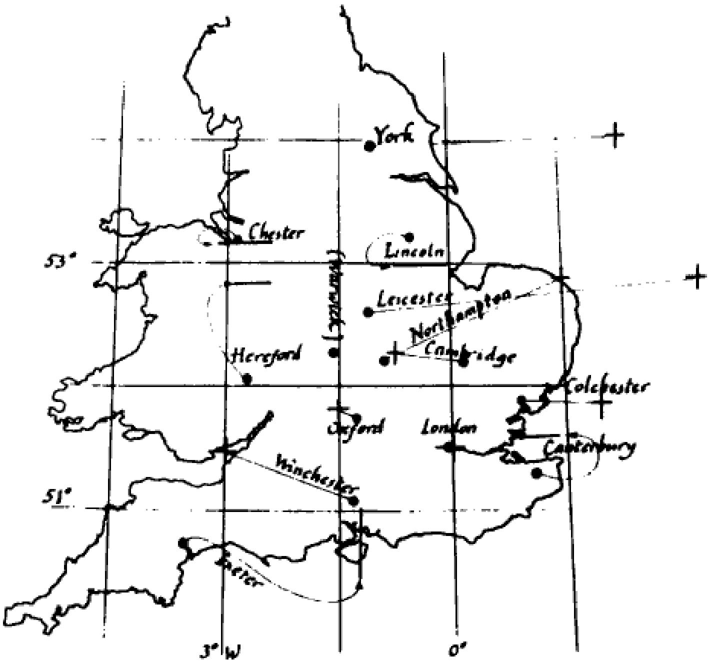
Knowledge of latitude and longitude as evidenced by a geographical list in MS. Ashmole 340

As explained in section II.24 above, this manuscript appears to stem from Norwich, and to date from c.1500. A list of towns appears at f. 76r. It is by no means as full as that given in Appendix III, but it can hardly be a worse case of eclecticism than William of Worcester's list. It may be used to illustrate well the errors that prevailed in the coordinates accepted for places in a single country, for fourteen out of a total of thirty-three places on the list are English. They are shown, with modern spelling, on the adjacent map. Black spots mark their correct places. Plotted on the map are the coordinates listed in the manuscript, but with certain adjustments to the longitudes. These are all adjusted in fact by an arbitrary 16;30°. To take Oxford as an example: in the table its longitude is given as 15;00° exactly, this being measured from an unspecified place – say the Canaries. This is then treated here as 1;30° west of Greenwich. Since London is given as 16;30°, the cross marking its position is on the Greenwich meridian. It will be seen that the eight places marked by crosses are by no means compatible in longitude (where there might be evidence for two different families of data), but are reasonably accurate in longitude.

Note that Hereford, Lincoln, Chester, and Canterbury are provided only with latitudes, and Exeter only with a longitude. In this respect, and in respect of its coordinates generally, the MS. is not particularly close to the William of Worcester list. Note too that since Warwick is placed at a latitude of 56;20°, it is possible that Berwick was intended. Note the odd 'Mirake' in the William of Worcester list (item 184).

One of the other towns listed is Toledo. Taking this as correct, the base of measurements would be around 15° west of Greenwich. The Alfonsine tables used in northern Europe in the fourteenth century took many forms, but we may say that some at least of the planetary tables for Oxford, London, and Paris, are compatible with a scheme that makes the intervals in degrees between these places as shown, exactly:

The West – 11° – Toledo – 4° – Oxford – 4° – London – 4° – Paris.



APPENDIX 4

A Computer Program to Analyse the Equation of a Horoscope

The calculations involved in executing the recommendations of this book are often very tedious, and a small calculator with trigonometrical functions, while sufficient in itself (in fact this book was compiled up to the present point with nothing more), is not enough to sustain many readers in the analysis of a figure by more than one or two of the seven main alternative methods. To make the procedures easy enough for almost anyone to follow, I have developed a computer program written in the Pascal language. This is reproduced in the following pages – which need not, of course, be understood in the slightest degree by the user. More precisely, the program makes use of MS-DOS Pascal. (Those who wish to modify it will note the presence of some non-standard features, notably the meta-command at the beginning, and the use of the 'otherwise' clause. In order to obtain the accuracy of real 8 arithmetic, some standard Fortran functions are declared extern, and three functions for conversion between radian measure and sexagesimal and decimal degrees are also declared extern. These are simple functions that the compiler will be able to provide.)

Once the necessary program has been compiled (here with a filename HOROSC.EXE), whether by the user or someone else, it is effected in a very simple way: for example, if one were using a personal computer of a kind operating on the system MS-DOS, it is switched on, and the word HOROSC is typed. Nothing more. The program then leads one on by a series of prompts, as partially illustrated in the following selections from what was seen on the screen at various stages in the analysis of a horoscope taken from an illustration in a bookseller's catalogue. It is in fact from the title page of an edition of Magini's *Ephemerides* covering the years 1617 and 1630 (Venice, 1616). It shows that he was using a latitude of 45 degrees and that – for all that he spent a good deal of time investigating the alternatives – he was taking our 'method 4', that of Regiomontanus. Here it might be of some interest to note that the British Museum copy of his *De astrologica ratione, ac usu dierum criticorum, seu decretiorum [etc.]* (Venice, 1607) belonged to Francis Bernard, and has Magini's own nativity in Bernard's hand at the front, also calculated on method 4. The same work contains many other examples, on this and other methods, and shows that Magini was prepared to borrow extensively.

Since there are no line numbers on the program reproduced below, it is important to notice that there are a few points at which lines in the program occupy more than one line of text. This should give no trouble to a reader with enough knowledge to compile and link the program. (Caution is also necessary over the spacing of reserved words.)

Here, before giving it in full, are some of the screens displayed, with numerous prompts (and safeguards in case instructions are not followed), when it is run:

[Screen 1. Note the representation of sexagesimals using the decimal point, as is customary on small calculators.]

```
A›HOROSC
```

PROGRAM TO EQUATE A NEW HOROSCOPE OR ANALYSE AN EXISTING ONE

NOTE: When you are prompted for a letter, give it in UPPER CASE and follow with the carriage return.

If the obliquity you are assuming (sexag.notation) is here, type the letter preceding it, otherwise type Z.
If you have no opinion, type P.

Standard values of the obliquity:

M:23.5120 N:23.51 O:23.35 P:23.3330
Q:23.30 R:23.3130.

R

[Screen 2. **Bold** letters and numerals are used here to indicate whatever is typed in by the user. Had you chosen **A**, the choice at the end of the screen would not have been offered.]
For future reference, this is point E (Entry point) of the program. You will later be given an opportunity to return.

You now have a choice of two procedures. You may supply:

(A) The longitude of the ascendent and the known latitude of place; or
(B) The longitudes of the cusps of houses 1 to 6.
Types in the letter A or B: **B**
Type in the sexages. values of the longitudes of the cusps.
Longitude of cusp no 1: **269.12**
Longitude of cusp no 2: **305.10**
Longitude of cusp no 3: **352.55**
Longitude of cusp no 4: **26.50**
Longitude of cusp no 5: **48.23**
Longitude of cusp no 6: **66.48**

Do you wish to derive a figure for the geographical latitude ? Type Y or N (Yes or No).

Y

[Screen 3. It is significant that a round 45° for the latitude lies within only one range of uncertainty.]

```
To decide on the uncertainty in the geog. lat. to be derived you must conjecture as to
how longitudes were rounded. Select from the following list:

Rounding to [A] half a degree; [B] a degree;
Rounding to [C] 10 mins arc; [D] 1 min. arc.
Rounding to [E] half min.; [F] 1 sec. arc.
Type the appropriate letter.

D
The derived geog. lat. in sexages. notation is at the CENTRE of this set of five
values. The other figures represent two ranges of uncertainty – the upper and lower
the range on the assumption that the astrologer started from the ascendent, the
others assuming mid-heaven as a datum.
The latitudes derived are all in sexagesimal notation.
                                   45·0314

44·5705                            44·5702                            44·4430

                                   44·5048

C
```

[Screen 4. The table is chosen, on this first occasion, but we return later to choose first 4 and then 1.]

```
For future reference, this is the point M (Method and format selection). You will
later be able to return, if you wish, without the need to supply new data.

You must now decide whether you want right ascensions and longitudes of the
houses by a single method (you will be able to repeat the procedure for another
method), OR a table of longitudes only, but done on seven different methods.

Only if you have already provided a full set of cusp longitudes will an assessment of
quality be provided.

Type in the appropriate numeral or letter.
  (T) For the TABLE                    (0) Hour-lines (fixed bds)
  (1) Standard method                  (2) Dual longitude method
  (3) Prime vertical method            (4) Equatrl (fixed bds)
  (5) Equatorial (hses r.a. 30)        (6) Single long. (30 deg.)
                       TYPE S TO END THE SESSION

T
```

[Screen 5. The quality coefficient is the mean of the absolute values of the differences between the cusps provided for houses 2, 3, 5, and 6, and the ideal values. See screens 6 and 7. Note that the coefficient under column 4 is by far the best.]

```
TABLE OF CUSP LONGITUDES ON THE SEVEN METHODS (0 TO 6)

Note that the coefficient of quality is quoted only in cases where a full set of six
cusps was provided.

METHOD    0         1         2         3         4         5         6
L1     269.1200  269.1200  269.1200  269.1200  269.1200  269.1200  269.1200
L2     309.5631  305.2008  308.2440  319.4424  305.0830  297.0346  299.1200
L3     353.2847  345.0631  347.3720    3.2805  352.5247  326.5340  329.1200
L4      26.5000   26.5000   26.5000   26.5000   26.500   359.0254  359.1200
L5      50.5950   48.4623   47.3720   43.2357   48.2259   31.1718   29.1200
L6      70.3251   69.2412   68.2440   61.0400   66.4806   61.1615   59.1200

QUAL      2.925     2.743     2.728    48.685     0.016    14.188    14.117

To recalculate the same data by another METHOD (or methods), type M.
To return to the ENTRY point, at which you were offered a choice between two
sorts of input, type E.
```

M

[Screen 6. This follows our typing 4, in response to a repetition of screen 4. The two ascensions quoted are checks on the original working, in cases (frequently encountered) where the astrologer has written them in above and to the left of the 'square'.]

```
Ideal values for the cusp longitudes (sexages.):
        (1) 269.1200        (2) 305.0830        (3) 352.5247
        (4)  26.5000        (5)  48.2259        (6)  66.4806

The right ascension of (upper) mid-heaven is   204.5258
The oblique ascension of the ascendent is   294.5258
The absolute differences between the theoretically correct cusp longitudes and those
you provided, in decimal parts of a degree, are as follows (1 and 4 zero by
definition):
        (1) 0.000        (2) 0.025        (3) 0.037
        (4) 0.000        (5) 0.000        (6) 0.002
The coefficient of the quality of the scheme is 0.016
```

[Screen 7. This follows our selection of method 1, from screen 4. It illustrates the full set of right ascensions displayed in five out of the seven methods (not 3 or 4).]

```
Ideal values for the right ascensions (sexages.):
        (1) 269.0739        (2) 307.4245        (3)346.1752
        (4)  24.5258        (5)  46.1752        (6)  67.4245
Ideal values for the cusp longitudes (sexages.):
        (1) 269.1200        (2) 305.2008        (3) 345.0631
        (4)  26.5000        (5)  48.4623        (6)  69.2412
```

```
The absolute differences between the theoretically correct cusp longitudes and those
you provided, in decimal parts of a degree, are as follows (1 and 4 zero by
definition):
        (1) 0.000        (2) 0.169        (3) 7.808
        (4) 0.000        (5) 0.390        (6) 2.603

The coefficient of the quality of the scheme is 2.743
(If the coefficient is not less than 1, it is unlikely that you have located the method
used.)
The smaller the coefficient, the better the quality of fit.
To recalculate the same data by another METHOD (or methods), type M.
To return to the ENTRY point, at which you were offered a choice between two
sorts of input, type E.
If you want to return to the BEGINNING, where you will be able to supply a new
figure for the obliquity, type B.

Type S if you wish to STOP.
```

[The quality coefficient appearing in the last three of our sample screens is such a that horoscope accurate to a minute of arc should yield a value of 0.01667, and if quoted to seconds, and accurate to a second, 0.000278. Note the accuracy of the Magini example, and compare the coefficient of 0.016 with 0.046 derived for the horoscope (220144) in which cusp longitudes were quoted to sexagesimal *thirds*.]

```
 PROGRAM HOROSC(INPUT, OUTPUT);
{for the analysis of a horoscope, given cusp longitudes}

{$real:8}

CONST
PI= 3.14159265358979;
TYPE
ary= ARRAY[0..6]OF real;
arry= ARRAY[0..7,0..6] of real;
VAR
i: integer;
j: integer;
m: integer;
X: real;
BRACKET: real;
TANFI: real;{tan lat, at a later stage }
NUM: real;
DEN: real;
L: arry;{eclipt.long. input}
EE: char;{to take input codes}
EEE: char;{ditto}
QQ:char;{code for type of input}
E: real;{obliquity}
F: real;{geogr.lat. in rads}
OFO: real;{mean value of F, i.e. central value}
FOO: real;{'origin' in sq. of uncertainty for F}
FOI: real;
FII: real;
FIO: real;
A: arry;{rt. ascens.}
DELTA: arry;{variation from the mean (hse size)}
Q: ary;{quality coeff}
B: real;{auxiliary term only}
C: real;
B1:ary;{auxil}
BB:arry;{auxil}
DISP: arry; {display of above}
H: real;{parameter h in methods 3 and 4}
THETA: real;{theta in equation(11)}
ERR: real;{error through rounding}
TT: real;{product tangents obliqu.& latit.}
FUNCTION SR(X:real8):real8;EXTERN;
FUNCTION RS(X:real8):real8;EXTERN;
FUNCTION DS(X:real8):real8;EXTERN;
FUNCTION A2DRQQ(CONSTS T,C:real8):real8;EXTERN;{Fortran}
FUNCTION CNDRQQ(CONSTS A:real8):real8;EXTERN;
FUNCTION SNDRQQ(CONSTS A:real8):real8;EXTERN;
FUNCTION TNDRQQ(CONSTS A:real8):real8;EXTERN;
FUNCTION ATDRQQ(CONSTS A:real8):real8;EXTERN;
FUNCTION ASDRQQ(CONSTS A:real8):real8;EXTERN;
FUNCTION ACDRQQ(CONSTS A:real8):real8;EXTERN;{end
Fortran fns}

FUNCTION ECEQ(E,LL:real):real;{convs long. to rt.asc.}
BEGIN
C:=CNDRQQ(LL);
B:=SNDRQQ(LL)*CNDRQQ(E);
X:=A2DRQQ(B,C);
IF (A2DRQQ(B,C)<0.0) THEN
X:=A2DRQQ(B,C) +PI*2.0;
IF ABS(X-LL)>PI/5.0 THEN
X:=X+PI;
IF X>PI*2.0 THEN
X:=X-PI*2.0;
ECEQ:=X
END;{FUNCTION eceq}

FUNCTION EQEC(E,AA:real):real;{converts rt.asc.to long.}
BEGIN
C:=CNDRQQ(AA);
B:=SNDRQQ(AA)/CNDRQQ(E);
X:=A2DRQQ(B,C);
IF (A2DRQQ(B,C)<0.0) THEN
X:=PI*2.0+A2DRQQ(B,C);
IF ABS(X-AA)>PI/5.0 THEN
X:=X+PI;
IF X>PI*2.0 THEN
X:=X-PI*2.0;
EQEC:=X
END;{FUNCTION eqec}

FUNCTION LAT(E: real;j:integer):real;
BEGIN
BRACKET:=A[j,4]-A[j,1];
NUM:=CNDRQQ(BRACKET);
DEN:=TNDRQQ(E)*SNDRQQ(A[j,1]);
X:=ABS(A2DRQQ(NUM,DEN));
IF (X<0.0) THENX:=X+PI*2.0;
IF (X>PI/2.0) AND (X<PI) THEN X:=PI-X;
LAT:=X
END;{latitude calculation}

PROCEDURE ITERATE(var m: integer);
```

```
BEGIN
i:=m;
REPEAT
BB[0,i]:=A[0,i];
X:= SNDRQQ(BB[0,i])*TNDRQQ(E)*TNDRQQ(F);
BRACKET:=ACDRQQ(X);
BRACKET:=BRACKET/3.0;
BB[0,i]:= A[0,4]-(4-i)*BRACKET;
IF BB[0,i]<0.0 THEN BB[0,i]:=BB[0,i]+PI*2.0;
IF BB[0,i]>PI*2.0 THEN BB[0,i]:=BB[0,i]-PI*2.0;
ERR:=ABS(BB[0,i]-A[0,i]);
A[0,i]:=BB[0,i];
UNTIL (ERR<0.000002)
END;

PROCEDURE LONGDISP(var DISP:arry; var m:integer);
BEGIN
j:=m;
WRITELN('Ideal values for the cusp longitudes
(sexages.):');
FOR i:=1 to 6 DO
BEGIN
WRITE(i,')',DISP[j,i]:8:4,' ');
 IF (i mod 3 =0) THEN WRITELN
END
END;{display of longitudes}

PROCEDURE RADISP(var A:arry;var m:integer);
BEGIN
j:=m;
WRITELN('Ideal values for the right ascensions
(sexages.):');
FOR i:=1 TO 6 DO
BEGIN
WRITE(i,')',RS(A[j,i]):8:4,'  ');
IF (i MOD 3=0) THEN WRITELN;
END
END;{display of right ascensions}

PROCEDURE QUALDISP(var L:arry; var m: integer);
BEGIN{   calcn diffs, case B only}
WRITELN('The absolute differences between the
theoretically correct');
WRITELN('cusp longitudes and those you provided, in
decimal parts');
WRITELN('of a degree, are as follows (1 and 4 zero by
definition):');
```

```
FOR i:=1 TO 6 DO
BEGIN
j:=m;
DELTA[j,i]:=ABS(L[j,i]-L[7,i]);
IF DELTA[j,i]>PI THEN
DELTA[j,i]:=ABS(PI*2.0-DELTA[j,i]);
WRITE(i,')', ((180.0/PI)*DELTA[j,i]):6:3);
IF (i mod 3=0) THEN WRITELN;
END;{   display of diffs in degrees}

Q[j]:=DELTA[j,2]+DELTA[j,3]+DELTA[j,5]+DELTA[j,6];
Q[j]:= (180.0/PI)*Q[j]/4.0;
WRITELN;
WRITELN('The coefficient of the quality of the scheme is
',Q[j]:5:3);
WRITELN('(If the coefficient is not less than 1, it is
unlikely that');
WRITELN('you have located the method used.)');
WRITELN('The smaller the coefficient, the better the
quality of fit.');
END;{   procedure qualdisp}

PROCEDURE METHOD1;
BEGIN
WRITELN;
BRACKET :=A[1,4]-A[1,1];
IF BRACKET<0.0 THEN
BRACKET:=BRACKET+PI*2.0;
A[1,2]:=A[1,1]+BRACKET/3.0;
A[1,3]:=A[1,2]+BRACKET/3.0;
BRACKET:=PI-BRACKET;
A[1,5]:=A[1,4]+BRACKET/3.0;
A[1,6]:=A[1,5]+BRACKET/3.0;
FOR i:=2 to 6 DO
BEGIN
IF (A[1,i]>=PI*2.0) THEN
A[1,i]:=A[1,i]-PI*2.0
END;
FOR I:=1 TO 6 DO
BEGIN
L[1,i]:=EQEC(E,A[1,i]);
IF ((A[1,i]-L[1,i])>PI/3.0) THEN
L[1,i]:=L[1,i]+PI;
IF ((L[1,i]-A[1,i])>PI/3.0) THEN
L[1,i]:= L[1,i] - PI;
IF (L[1,i]>PI*2.0) THEN
L[1,i]:=L[1,i]-PI*2.0;
```

```
IF (L[1,i]<0.0) THEN
L[1,i]:=L[1,i] + PI*2.0;
DISP[1,i]:= RS(L[1,i])
END
END;{Procedure METHOD1 }

PROCEDURE METHOD2;
BEGIN
BRACKET:=L[2,4]-L[2,1];
IF (BRACKET<0.0) THEN BRACKET:=BRACKET+PI*2.0;
BRACKET:=BRACKET/3.0;
L[2,2]:=L[2,1]+ BRACKET;
L[2,3]:=L[2,2] + BRACKET;
BRACKET:=PI/3.0 - BRACKET;
L[2,5]:=L[2,4] + BRACKET;
L[2,6]:=L[2,5] + BRACKET;
FOR i:= 1 to 6 DO
BEGIN
IF (L[2,i]>2.0*PI) THEN
L[2,i]:=L[2,i]-2.0*PI;
A[2,i]:=ECEQ(E,L[2,i]);
DISP[2,i]:=RS(L[2,i])
END
END;{Procedure METHOD2}

PROCEDURE METHOD3;
BEGIN
FOR i:=1 TO 6 DO
BEGIN
IF i<>4 THEN
BEGIN
THETA:=(i-1)*PI/6.0;
NUM:=TNDRQQ(THETA);
DEN:=CNDRQQ(F);
H:=A2DRQQ(NUM,DEN);
IF H<0.0 THEN H:=H+PI;
X:=A[3,4] - PI/2.0 + H;
IF X<0.0 THEN X:=X+PI*2.0;
IF X>PI*2.0 THEN X:=X-PI*2.0;
NUM:= SNDRQQ(X);
DEN:= CNDRQQ(X)*CNDRQQ(E)-CNDRQQ(H)*TNDRQQ(F)*SNDRQQ(E);
L[3,i]:=A2DRQQ(NUM,DEN);
IF L[3,i]<0.0 THEN L[3,i]:=L[3,i]+PI*2.0;
IF ABS(L[3,i]-X)>PI/3.0 THEN
L[3,i]:=L[3,i]-PI;
IF L[3,i]<0.0 THEN
L[3,i]:=L[3,i]+PI*2.0;
```

```
DISP[3,i]:=RS(L[3,i]);
END
ELSE
DISP[3,i]:=RS(L[7,i])
END
END;{Procedure Method 3}

PROCEDURE METHOD4;
BEGIN
FOR i:= 1 TO 6 DO
BEGIN
IF i<>4 THEN
BEGIN
H:=(i-1)*PI/6.0;
X:=A[4,4] - PI/2.0 + H;
IF X<0.0 THEN X:=X+PI*2.0;
IF X>PI*2.0 THEN X:=X-PI*2.0;
NUM:= SNDRQQ(X);
DEN:= CNDRQQ(X)*CNDRQQ(E)-CNDRQQ(H)*TNDRQQ(F)*SNDRQQ(E);
L[4,i]:=A2DRQQ(NUM,DEN);
IF L[4,i]<0.0 THEN L[4,i]:=L[4,i]+PI*2.0;
IF ABS(L[4,i]-X)>PI/3.0 THEN
L[4,i]:=L[4,i]-PI;
IF L[4,i]<0.0 THEN
L[4,i]:=L[4,i]+PI*2.0;
DISP[4,i]:=RS(L[4,i])
END
ELSE
DISP[4,i]:=RS(L[7,i])
END
END;{Procedure Method4}

PROCEDURE METHOD5;
BEGIN
FOR i:=2 TO 6 DO
BEGIN
A[5,i]:=A[5,1]+ PI*(i-1)/6.0;
IF (A[5,i]>PI*2.0) THEN
A[5,i]:=A[5,i] - PI*2.0
END;
FOR i:=1 TO 6 DO
BEGIN
L[5,i]:=EQEC(E,A[5,i]);
DISP[5,i]:=RS(L[5,i])
END
END;{Procedure Method5}
```

```
PROCEDURE METHOD6;
BEGIN
FOR i:=2 to 6 DO
BEGIN
L[6,i]:=L[6,1]+ PI*(i-1)/6.0;
IF (L[6,i]>PI*2.0) THEN
L[6,i]:=L[6,i]-PI*2.0;
END;
FOR i:=1 to 6 DO
BEGIN
A[6,i]:=ECEQ(E,L[6,i]);
DISP[6,i]:=RS(L[6,i])
END
END;


BEGIN{MAIN PROGRAM BEGINS}
WRITELN;
WRITELN;
WRITELN;
WRITELN;
WRITELN('PROGRAM TO EQUATE A NEW HOROSCOPE OR ANALYSE AN
EXISTING ONE');
WRITELN;
WRITELN;
WRITELN('NOTE: When you are prompted for a letter, give
it in UPPER CASE and foll
ow with the carriage return.');
WRITELN;
WHILE EE<>'S' DO
BEGIN{while loop}
WRITELN;
WRITELN;
WRITELN('If the obliquity you are assuming
(sexag.notation) is here,');
WRITELN('type the letter preceding it, otherwise type
Z.');
WRITELN('If you have no opinion, type P.');
WRITELN;
WRITELN;
WRITELN;
WRITELN('Standard values of the obliquity:');
WRITELN;
WRITELN('M:23.5120 N:23.51 O:23.35 P:23.3330 Q:23.30
R:23.3130.');
WRITELN;
READLN(EE);
```

```
CASEEE OF{case statement}
'Z': BEGIN
WRITELN;
WRITELN;
WRITELN('Type in the sexagesimal value you wish to
assume: ');
READLN(X)
END;
'M': X:=23.5120;
'N': X:=23.5100;
'O': X:=23.3500;
'P': X:=23.3330;
'Q': X:=23.3000;
'R': X:=23.3130;
OTHERWISE
WRITELN ('You did not follow instructions carefully.');
WRITELN ('Case P is being assumed.');
X:= 23.3330
END;{case statement}
E:=SR(X);

EEE:='E';
REPEAT{allows a return to this point from near the end
of the prog.}
WRITELN;
WRITELN;
WRITELN;
WRITELN;
WRITELN('For future reference, this is point E (Entry
point) of the program.');
WRITELN('You will later be given an opportunity to
return.');
WRITELN;
WRITELN('You now have a choice of two procedures. You
may supply:');
WRITELN;
WRITELN('(A) The longitude of the ascendent and the
known ');
WRITELN('    latitude of place; or ');
WRITELN('(B) The longitudes of the cusps of houses 1 to
6.');
WRITE('Type in the letter A or B: ');
READLN(QQ);
CASE QQ OF
'A': BEGIN
WRITELN;
WRITE('Type in the longitude of the ascendent (sexag.):
```

```
');
READLN(L[7,1]);
WRITE('Type in the latitude (sexages.):  ');
READLN(F);
F:=SR(F);
L[7,1]:=SR(L[7,1]);
A[7,1]:= ECEQ(E,L[7,1]);
TT:=TNDRQQ(E)*TNDRQQ(F);
BB[7,1]:=SNDRQQ(A[7,1])*TT;{BB a convenient auxil.}
A[7,0]:=A[7,1]-ASDRQQ(BB[7,1]);
A[7,4]:= PI/2.0 + A[7,0];
IF A[7,4]>=PI*2.0 THEN A[7,4]:=A[7,4]-PI*2.0;
IF A[7,4]<0.0 THEN A[7,4]:=A[7,4]+PI*2.0;
L[7,4]:=EQEC(E,A[7,4]);
{rt. ascens. and long. of ascendent & mid-heaven
known,case A}
END;{ case A}

'B':BEGIN{case B}
WRITELN('Type in the sexages. values of the longitudes
of the cusps.');
FOR i:=1 to 6 DO{loop to accept data on longitudes}
BEGIN{loop}
WRITE('Longitude of cusp no.',i:1,': ');
READLN(L[7,i]);
END;
FOR i:= 1 to 6 DO
BEGIN
L[7,i]:=SR(L[7,i]);
A[7,i]:=ECEQ(E,L[7,i]);
END{conversions}
END;{case B}
OTHERWISE
BEGIN
WRITELN;
WRITELN;
WRITELN('***   You have not followed instructions
carefully !  ***');
QQ:='S'
END{otherwise clause}
END;{CASE STATEMENT now complete}

IF QQ='B' THEN
BEGIN
WRITELN;
WRITELN('Do you wish to derive a figure for the
geographical ');
```

```
WRITELN('latitude ? Type Y or N (Yes or No).');
READLN(EEE);
IF EEE='Y' THEN
BEGIN
WRITELN;
WRITELN('To decide on the uncertainty in the geog.lat.to
be derived');
WRITELN('you must conjecture as to how longitudes were
rounded.');
WRITELN('Select from the following list:');
WRITELN;
WRITELN('Rounding to [A] half a degree;[B] a degree;');
WRITELN('Rounding to [C] 10 mins arc; [D] 1 min arc.');
WRITELN('Rounding to [E] half min.;   [F] 1 sec. arc.');
WRITELN('Type the appropriate letter.');
READLN(EE);
CASE EE OF
'A': ERR:=0.008726646;
'B': ERR:=0.017453293;
'C': ERR:=0.002908882;
'D': ERR:=0.001745329;
'E': ERR:=0.00087266;
'F': ERR:=0.000029089;
OTHERWISE
BEGIN
WRITELN('You did not follow instructions carefully.');
WRITELN('A rounding error of one degree is assumed.');
ERR:=0.017453293;
END
END{of case statement}
END{option to find range of latitude}
END;

FOR j:= 0 TO 6 DO
BEGIN{copying procedure for ascendent and lmc}
A[j,1]:= A[7,1];
A[j,4]:= A[7,4];
L[j,1]:=L[7,1];
L[j,4]:=L[7,4];
END;{transfer longitudes and rt.asc. to 7 branches}
{note that some of these data will be overridden later}

IF QQ= 'B' THEN
BEGIN
j:=1;
F:=LAT(E,j);{reserved for later use}
OFO:=LAT(E,j)*(180.0/PI);
```

```
IF EEE='Y' THEN
BEGIN
A[1,4]:=A[1,4]-ERR;
FOO:=LAT(E,j)*(180.0/PI);
A[1,4]:=A[1,4]+ERR*2.0;
FII:=LAT(E,j)*(180.0/PI);
A[1,1]:=A[1,1]-ERR;
A[1,4]:=A[1,4]-ERR*2.0;
FOI:=LAT(E,j)*(180.0/PI);
A[1,1]:=A[1,1]+ERR*2.0;
FIO:=LAT(E,j)*(180.0/PI);
WRITELN('The derived geog. lat. in sexages. notation is
at the CENTRE');
WRITELN('of this set of five values. The other figures
represent two');
WRITELN('ranges of uncertainty--the upper and lower the
range on the');
WRITELN('assumption that the astrologer started from the
ascendent,');
WRITELN('the others assuming mid-heaven as a datum.');
WRITELN('The latitudes derived are all in sexagesimal
notation.');
WRITELN('                  ',DS(FII):8:4);
WRITELN;
WRITELN(DS(FOI):8:4,'          ',DS(OFO):8:4,'
',DS(FIO):8:4);
WRITELN;
WRITELN('                  ',DS(FOO):8:4);
WRITELN;
WRITELN('Type C to continue.');
READLN(EE);
A[1,1]:=A[7,1];{copy to restore correct input value}
A[1,4]:=A[7,4]
END{choice Y/N of deriving latitude}
END;{latitude assessment, case B only}
{note that a central latit. is known,case B, and is in
variable F}
EEE:='M';
IF QQ<>'S' THEN
BEGIN
REPEAT
WRITELN;
WRITELN('For future reference, this is the point M
(Method and format selection).
');
WRITELN('You will later be able to return, if you wish,
without the');
```

```
WRITELN('need to supply new data.');
WRITELN;
WRITELN('You must now decide whether you want right
ascensions and');
WRITELN('longitudes of the houses by a single method
(you will be');
WRITELN('able to repeat the procedure for another
method), OR a table');
WRITELN('of longitudes only, but done on seven different
methods.');
WRITELN;
WRITELN;
WRITELN('Only if you have already provided a full set of
cusp');
WRITELN('longitudes will an assessment of quality be
provided.');
WRITELN;
WRITELN(' Type in the appropriate numeral or letter.');
WRITELN('   (T) For the TABLE          (0) Hour-lines
(fixed bds)');
WRITELN('   (1) Standard method        (2) Dual
longitude method');
WRITELN('   (3) Prime vertical method  (4) Equatrl
(fixed bds) ');
WRITELN('   (5) Equatorial(hses r.a.30)(6) Single
long.(30 deg.)');
WRITELN('                  TYPE S TO END THE SESSION');
WRITELN;
READLN(EE);
CASE EE OF
'T':
BEGIN{with Method 0}
B:=ABS(A[0,4]-A[0,1]);
IF B>PI*2.0 THEN B:=B-PI*2.0;
B:=B/3.0;
A[0,2]:=A[0,1] + B;
IF A[0,2]>PI*2.0 THEN A[0,2]:=A[0,2]-PI*2.0;
A[0,3]:=A[0,2] + B;
IF A[0,3]>PI*2.0 THEN A[0,3]:=A[0,3]-PI*2.0;
A[0,5]:=A[0,4] + PI/3.0-B;
IF A[0,5]>PI*2.0 THEN A[0,5]:=A[0,5]-PI*2.0;
A[0,6]:=A[0,5] + PI/3.0-B;
IF A[0,6]>PI*2.0 THEN A[0,6]:=A[0,6]-PI*2.0;
m:=2;
ITERATE(m);
m:=3;
ITERATE(m);
```

```
m:=5;
ITERATE(m);
m:=6;
ITERATE(m);
FOR i:=1 to 6 DO
BEGIN
L[0,i]:=EQEC(E,A[0,i]);
DISP[0,i]:= RS(L[0,i])
END;

METHOD1;

METHOD2;

METHOD3;

METHOD4;

METHOD5;

METHOD6;
{TABULATION begins}
WRITELN('TABLE OF CUSP LONGITUDES ON THE SEVEN METHODS
(0 TO 6)');
WRITELN;
WRITELN('Note that the coefficient of quality is quoted
only in');
WRITELN('cases where a full set of six cusps was
provided.');
WRITELN;
WRITELN('METHOD   0        1        2        3        4
5        6');
WRITELN('__________________________________________________
____________________');
WRITELN('L1    ',DISP[0,1]:8:4,' ',DISP[1,1]:8:4,'
',DISP[2,1]:8:4,' ', DISP[3,1]
:8:4,' ',DISP[4,1]:8:4,' ',DISP[5,1]:8:4,'
',DISP[6,1]:8:4);
WRITELN('L2    ',DISP[0,2]:8:4,' ',DISP[1,2]:8:4,'
',DISP[2,2]:8:4,' ', DISP[3,2]
:8:4,' ',DISP[4,2]:8:4,' ',DISP[5,2]:8:4,'
',DISP[6,2]:8:4);
WRITELN('L3    ',DISP[0,3]:8:4,' ',DISP[1,3]:8:4,'
',DISP[2,3]:8:4,' ', DISP[3,3]
:8:4,' ',DISP[4,3]:8:4,' ',DISP[5,3]:8:4,'
',DISP[6,3]:8:4);
WRITELN('L4    ',DISP[0,4]:8:4,' ',DISP[1,4]:8:4,'
',DISP[2,4]:8:4,' ', DISP[3,4]
:8:4,' ',DISP[4,4]:8:4,' ',DISP[5,4]:8:4,'
',DISP[6,4]:8:4);
WRITELN('L5    ',DISP[0,5]:8:4,' ',DISP[1,5]:8:4,'
',DISP[2,5]:8:4,' ', DISP[3,5]
:8:4,' ',DISP[4,5]:8:4,' ',DISP[5,5]:8:4,'
',DISP[6,5]:8:4);
WRITELN('L6    ',DISP[0,6]:8:4,' ',DISP[1,6]:8:4,'
',DISP[2,6]:8:4,' ', DISP[3,6]
:8:4,' ',DISP[4,6]:8:4,' ',DISP[5,6]:8:4,'
',DISP[6,6]:8:4);
WRITELN;
{addition of quality coeffs if justifiable}
IF (QQ='B') THEN
BEGIN
FOR j:=0 TO 6 DO
BEGIN
FOR i:=1 TO 6 DO
BEGIN
DELTA[j,i]:=ABS(L[j,i]-L[7,i]);
IF DELTA[j,i]>PI THEN DELTA[j,i]:=DELTA[j,i]-PI;
Q[j]:=DELTA[j,2]+DELTA[j,3]+DELTA[j,5]+DELTA[j,6];
Q[j]:= (180.0/PI)*Q[j]/4.0;
END
END;
WRITELN('QUAL   ', Q[0]:6:3,'   ',Q[1]:6:3,'
',Q[2]:6:3,'   ',Q[3]:6:3,'   ',Q[
4]:6:3,'   ',Q[5]:6:3,'   ',Q[6]:6:3);
WRITELN
END{display of coefficients of quality}
END;{of the longest case, T for Tabulation}
{Cases 0 to 6 follow}
'0' :
BEGIN
{we begin by providing estimates of cusp rt.ascensions}
B:=ABS(A[0,4]-A[0,1]);
IF B>PI*2.0 THEN B:=B-PI*2.0;
B:=B/3.0;
A[0,2]:=A[0,1] + B;
IF A[0,2]>PI*2.0 THEN A[0,2]:=A[0,2]-PI*2.0;
A[0,3]:=A[0,2] + B;
IF A[0,3]>PI*2.0 THEN A[0,3]:=A[0,3]-PI*2.0;
A[0,5]:=A[0,4] + PI/3.0-B;
IF A[0,5]>PI*2.0 THEN A[0,5]:=A[0,5]-PI*2.0;
A[0,6]:=A[0,5] + PI/3.0-B;
IF A[0,6]>PI*2.0 THEN A[0,6]:=A[0,6]-PI*2.0;
m:=2;
```

```
ITERATE(m);
m:=3;
ITERATE(m);
m:=5;
ITERATE(m);
m:=6;
ITERATE(m);
FOR i:=1 to 6 DO
BEGIN
L[0,i]:=EQEC(E,A[0,i]);
DISP[0,i]:= RS(L[0,i])
END;
m:=0;
RADISP(A,m);
LONGDISP(DISP,m);
IF QQ='B' THEN
QUALDISP(L,m);
END;{cusps by hour-lines fixed bds method}

'1':
BEGIN
METHOD1;

m:=1;
RADISP(A,m);
LONGDISP(DISP,m);
IF (QQ='B') THEN
QUALDISP(L,m);
END;{case 1}
'2' :
BEGIN
METHOD2;

m:=2;
RADISP(A,m);
LONGDISP(DISP,m);
IF (QQ='B') THEN QUALDISP(L,
END;{case 2}

'3':
BEGIN
METHOD3;

m:=3;
LONGDISP(DISP,m);
WRITELN;
BB[3,4]:=A[3,4]+PI;{despite suffixes, BB is for
mid-heaven}
IF BB[3,4]<0.0 THEN BB[3,4]:=BB[3,4]+PI*2.0;
IF BB[3,4]>PI*2.0 THEN BB[3,4]:=BB[3,4]-PI*2.0;
BB[3,0]:=BB[3,4]+PI/2.0;
IF BB[3,0]<0.0 THEN BB[3,0]:=BB[3,0]+PI*2.0;
IF BB[3,0]>PI*2.0 THEN BB[3,0]:=BB[3,0]-PI*2.0;
WRITELN('The right ascension of (upper) mid-heaven is
',RS(BB[3,4]):8:4);
WRITELN('The oblique ascension of the ascendent is
',RS(BB[3,0]):8:4);
IF (QQ='B') THEN QUALDISP(L,m)
END;{case 3}


'4':
BEGIN
METHOD4;

m:=4;
LONGDISP(DISP,m);
WRITELN;
BB[4,4]:=A[4,4]+PI;{despite suffixes, BB is for
mid-heaven}
IF BB[4,4]<0.0 THEN BB[4,4]:=BB[4,4]+PI*2.0;
IF BB[4,4]>PI*2.0 THEN BB[4,4]:=BB[4,4]-PI*2.0;
BB[4,0]:=BB[4,4]+PI/2.0;
IF BB[4,0]<0.0 THEN BB[4,0]:=BB[4,0]+PI*2.0;
IF BB[4,0]>PI*2.0 THEN BB[4,0]:=BB[4,0]-PI*2.0;
WRITELN('The right ascension of (upper) mid-heaven is
',RS(BB[4,4]):8:4);
WRITELN('The oblique ascension of the ascendent is
',RS(BB[4,0]):8:4);
IF (QQ='B') THEN QUALDISP(L,m)
END;{case 4}

'5' :
BEGIN
METHOD5;

m:=5;
RADISP(A,m);
LONGDISP(DISP,m);
IF (QQ='B') THEN QUALDISP(L,m)
END;{case 5}
'6' : BEGIN
METHOD6;
```

```
m:=6;
RADISP(A,m);
LONGDISP(DISP,m);
IF (QQ='B') THEN QUALDISP(L,m)
END;{case 6}
OTHERWISE


END;{case statement}
WRITELN('To recalculate the same data by another METHOD
(or methods), type M.');
WRITELN('To return to the ENTRY point, at which you were
offered a');
WRITELN('choice between two sorts of input, type E.');
WRITELN('If you want to return to the BEGINNING, where
you will be');
WRITELN('able to supply a new figure for the obliquity,
type B.');
WRITELN;
WRITELN('Type S if you wish to STOP.');
READLN (EE);
EEE:=EE;
UNTIL (EEE<>'M')
END;
UNTIL (EEE<>'E')
END
END.{The whole program.}
```

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